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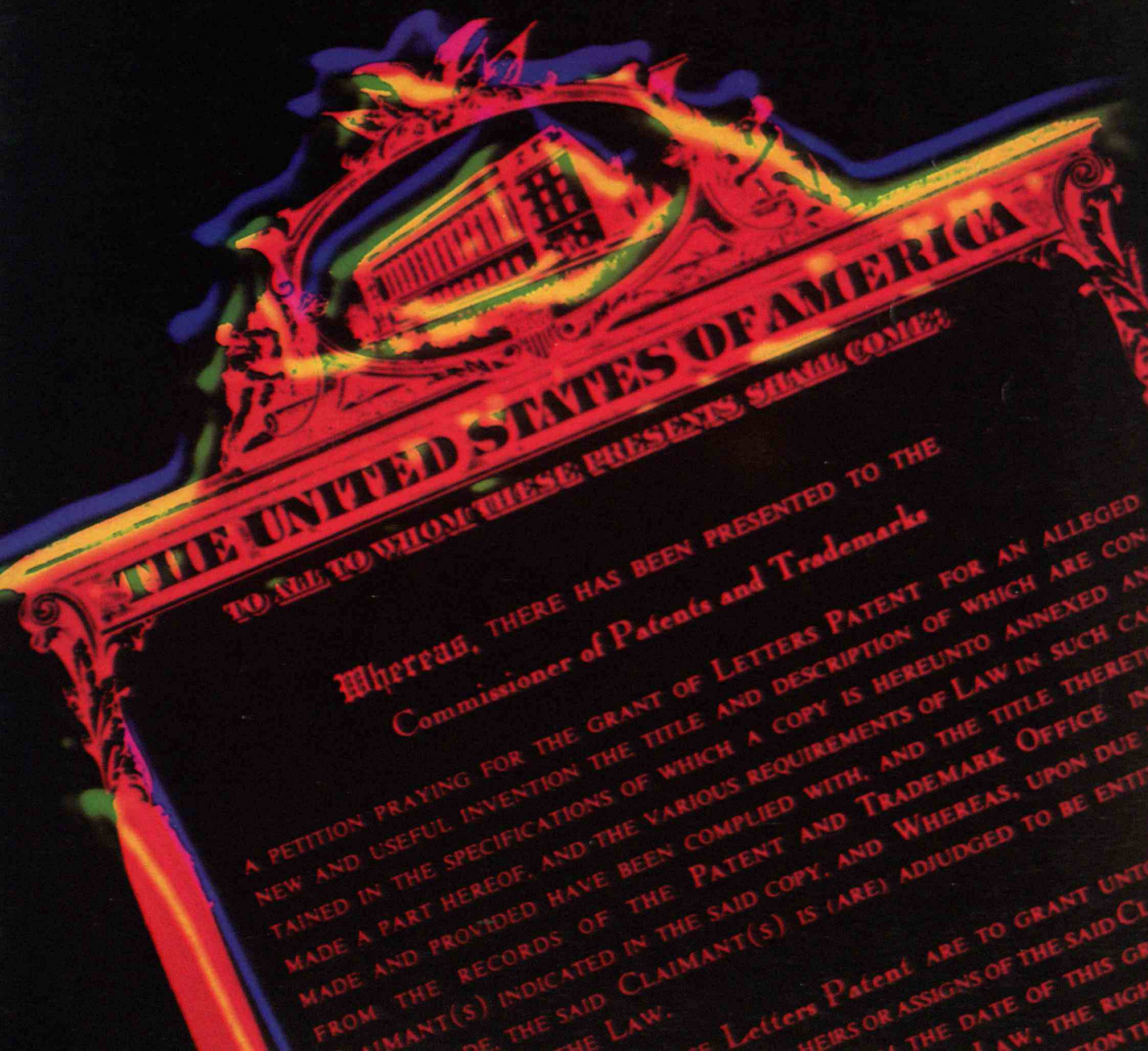

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Why so many Mercedes-Benz automobiles have achieved classic resale value – before they were old enough to be classics.

Each of the Mercedes-Benz automobiles in the picture at left has been shown to be actually worth more money today than the day it was new.

What makes this fact astonishing is that each is a production model and far from rare. And each was built in 1971–little more than a decade ago.

Astonishing consistency

The astonishingly consistent Mercedes-Benz legend of retained value is thus enhanced. A legend composed not just of a few exotic models, so rare and so old that their value could be expected to rise higher as the years pass by, but models you can see on the streets and highways of America every day–such as those in the picture at left.

True, the most money ever paid for a production automobile was paid for a Mercedes-Benz–a 1936 500K Roadster, auctioned in 1979 for four hundred thousand dollars. And the experts can cite numerous other Mercedes-Benz models now worth double, triple, quadruple their original selling prices.

But these same experts can attest to the remarkable overall record compiled by *all* Mercedes-Benz automobiles –sedans as well as coupes and roadsters, diesels alongside their gasoline-powered counterparts; from the recent past as well as the distant past. A record that is perhaps best expressed in one simple statement: the Mercedes-Benz name is so coveted by American buyers today that after the first three years, the *entire Mercedes-Benz line*–not just a few isolated models–has been shown to retain an average of 84 percent of original value.

Some individual models from some makers might possibly match this figure. In so doing, they only underscore the point: the Mercedes-Benz legend is not based on *some* cars, specially handpicked; it is based on the total resale performance of all models in the line.

Minimal depreciation

The net result has been a series of automobiles so desirable to so many people that their value has refused to tumble–refused, indeed, to more than minimally depreciate as the miles and years have gone by.

Perhaps this is because there have never been quite enough Mercedes-Benz automobiles to satisfy America's demand.

Perhaps it is because their value has never been cheapened by annual model changes, or face-lifts, or marketing artifice of any kind.

Perhaps–as the engineers would claim–it is simply because they are built to uncommon standards, to serve their owners uncommonly well.

A crucial measure

Not even Mercedes-Benz knows the reason to an absolute certainty. And not even Mercedes-Benz can predict the future course of resale value in this uncertain, unpredictable world of ours.

But that resale value stands as a crucial measure of automotive worth is beyond question. And amid the welter of claims and counterclaims about value retention in the marketplace today, the lessons of Mercedes-Benz resale history–*recent* resale history– cannot be discounted by any automobile buyer. And they should not be ignored.

Engineered like no other car in the world

◀ *Clockwise from top: 300 SEL 6.3 Sedan, 280 SL Roadster, 280 SE 3.5 Coupe, 280 SE 3.5 Convertible. 250 CE Coupe, 280 SE Sedan.*

FEB/MAR 1983 VOL. 86 NO. 2 EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Technology Review

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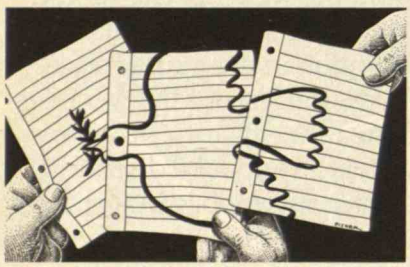

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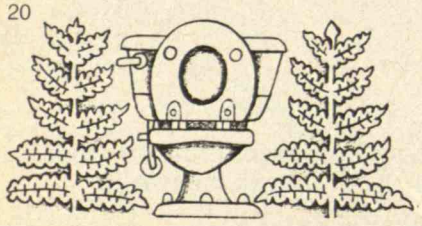

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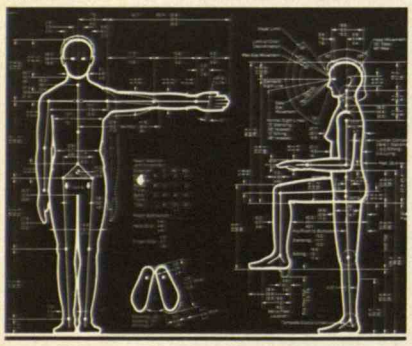

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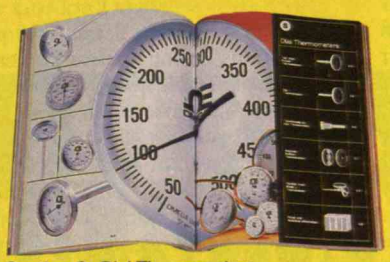

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Journalist of Science

We first asked Alison Bass to help us write and edit *Technology Review* nearly two years ago. She declined, having an opportunity to experience daily newspaper reporting at the *Miami Herald*. Last fall, when senior editor Ellen Ruppel Shell left us, we asked Alison again. This time she said yes, and it's a pleasure to introduce her to *Technology Review* readers—in this column and, already, elsewhere in this issue.

Ms. Bass studied English and American literature at Brandeis University with one year as Sachar Scholar in the School of English and American Studies at the University of East Anglia. Journalism was already her instinct: she wrote for *The Justice* at Brandeis and *Concrete* at East Anglia.

Ms. Bass's steady involvement with science began in 1977 when she joined the public-affairs staff of the Massachusetts Eye and Ear Infirmary. Her interest and commitment matured during two years (beginning in September 1978) of responsibility for medical and science news at the Harvard University News Office. Given that background, we're confident that she will flourish at *Technology Review*—and our readers with her.—*J.M.*

Double Standard and Diminishing Returns

Nuclear power's bleak future stems from one inescapable factor: public fear (*Richard K. Lester's "Is the Nuclear Industry Worth Saving?" and Edward J. Woodhouse's "Managing Nuclear Wastes: Let the Public Speak," October, pages 39 and 12*). Public anxiety over nuclear plants has become a moral crusade. But public debate over nuclear waste stems from a different kind of concern: that disposal facilities "might be acceptable for your county (or state), but certainly not for ours." While public referendum would be a democratic way to decide such questions, it would also be futile.
William B. McGorum, Jr.
Worthington, Ohio

Erosion of public support and the bias of the press are as significant as the financial, technical, and legislative obstacles to nuclear power. Industry, government, and the scientific community have an enormous task in convincing both the press and the public that the nuclear option is viable, reasonable, and necessary. Energy options have not changed since the National Academy of Sciences completed its exhaustive CONAES study three years ago. The study concluded that coal and nuclear should be our primary energy sources. The fact that the public and press understand this even less now than when the study was released shows the problem of revitalizing the nuclear industry.
Lynn Weaver
Auburn, Ala.

The writer is dean of the School of Engineering at Auburn University.

Mr. Lester omits one detail—the problem of decommissioning nuclear power plants. The lifetime of a typical reactor is about 25 years. The cost of decommissioning one is estimated at close to the cost of building the reactor in the first place. No competent business analyst would recommend sinking capital into a project that would turn into a negative economic force after 25 years. In the coming decade, more and more nuclear plants will reach the 25-year deadline. When the true costs of nuclear energy are figured, Mr. Lester's statement that "the current cost advantage of nuclear energy over coal may be eliminated, perhaps even reversed" becomes a supreme understatement.
Roger H. Olson
Boulder, Colo.

Doubting the Thomas Committee

In her review of my book *Love Canal: Science, Politics and People* (*October, page 85*), Ellen Williams portrays my chapter on the Thomas Committee, convened to pronounce the definitive verdict on the health hazards of Love Canal, as a disagreement over interpreting scientific data. She omits some crucial points.

□ The Thomas Committee was appointed at a time when the New York State Department of Health was under attack in the state legislature. The committee's report was understanding of the Health Department's problems but failed to remark that the department had not

produced reliable health studies despite the expenditure of $3,000,000.

☐ The Thomas Committee specifically asserted that there were no cases of "acute liver disease, or kidney disease, or pulmonary manifestations, of hemolytic anemia or agranulocytosis, and certainly no peripheral or central nervous system syndromes." As far as I could discover (the committee refused to answer my queries), no studies were available to enable the committee to reach such a conclusion. I resorted to the N.Y. Freedom of Information Act to acquire this information.

☐ As Ms. Williams noted, four of the five committee members were administrators of medical facilities regulated by the N.Y. Health Department. As I point out, department officials participated in the committee's deliberations, and the governor's political staff helped shape the final report. None of these contributions were acknowledged in the final report.

Adeline Gordon Levine
Buffalo, N.Y.

The Golden Mean

In "Technological Literacy: An Uneasy Victory" (*July, page 6*), Samuel Florman asks how new programs sponsored by the Sloan Foundation are to be introduced except "at the expense of medieval history, Elizabethan poetry, and the Russian novel." According to officers of the Sloan Foundation, courses in the humanities will not be displaced but enhanced by introducing technology-related material to topics such as "the forces of historical change," "the emergence of novel art forms," "the social matrix of political ideologies," and "problems of ethics."

Educators are responsible for preparing students majoring in the social sciences and humanities for meaningful careers in today's technological society. Technological literacy courses have been denied their proper place in the liberal-arts curriculum. Of course, we must continue to require that students have a thorough grounding in the humanities and social sciences, but not at the expense of the exploration of technology as a major cultural and social force.

Donald Hockney
Brooklyn, N.Y.

Donald Hockney is professor of the philosophy of science and technology and chairman of the Department of Humanities and Communication of the Polytechnic Institute of New York.

Mr. Florman replies:

It will be magical indeed if the Sloan Foundation is able to achieve technological literacy—including computer proficiency—merely by enriching existing courses in the liberal arts. Professor Hockney and I do agree that both technology and the humanities should be explored in the classroom. He is afraid that there may be too little technology, and I am concerned that students are turning away from the humanities. We are both seeking a proper balance.

A compact liquid-crystal light valve is designed to serve as a real-time light modulator for many optical data-processing and projection uses. The Hughes Aircraft Company light valve uses liquid-crystal and thin-film technology to combine high input-light sensitivity and high image resolution with low voltage and power requirements. Uses include: graphics projection systems for large-screen displays, high-resolution vision for industrial robots, radar and sonar signal-processing, identification of moving objects, high-resolution spectral analysis of wide-band signals, and hybrid optical-digital processing systems.

The electronic rocket engine is ready to be tested aboard a satellite to see how well it functions in the company of other space hardware. Hughes has delivered two engines, called mercury ion thrusters, for installation on a U.S. Air Force research satellite. The goal of the flight test is to qualify the system in space for performing such auxiliary propulsion functions as stationkeeping, attitude control, and orbit maneuvering of spacecraft. The system is designed to replace traditional chemical and gas propulsion systems, saving hundreds of pounds of weight. In operation, the thrusters are powered by the satellite's solar cells, which convert sunlight into electricity.

High efficiency solar cells now being developed could cut substantially the weight and area of some satellite solar panels. These cells, made with gallium arsenide by a special liquid-phase epitaxial growth process developed by Hughes scientists, have shown efficiencies higher than 19% in converting sunlight into electricity. This compares with efficiencies between 15% and 16% for the best available silicon solar cells. In addition, the gallium arsenide cells can operate at higher temperatures and can tolerate more high-energy proton irradiation in space than silicon solar cells.

A series of pulsed injection-locked IMPATT amplifiers, in single-stage or dual-stage configurations with two output power versions for each, has been added to the Hughes line of solid-state millimeter-wave transmitter products. The new amplifiers, designated the 4718xH series, are available in the 34-36 GHz frequency range (Ka-band) in 5-watt and 10-watt versions, and in the 92-96 GHz frequency range (W-band) in 3-watt and 5-watt versions.

Career growth opportunities exist at all levels at Hughes Support Systems for a variety of engineers qualified by degree or extensive work experience. They include systems engineers, applications engineers, software and hardware design engineers for major simulation and test equipment programs, and automatic test equipment engineers. Also, field engineering posts throughout the U.S. and the world offer travel, autonomy, and responsibility. Call collect (213) 513-5238. Or send your resume to Professional Employment, Dept. SE, Hughes Aircraft Company, P.O. Box 9399, Long Beach, CA 90810-0463. Equal opportunity employer.

The Hydrogen-from-Water Hype

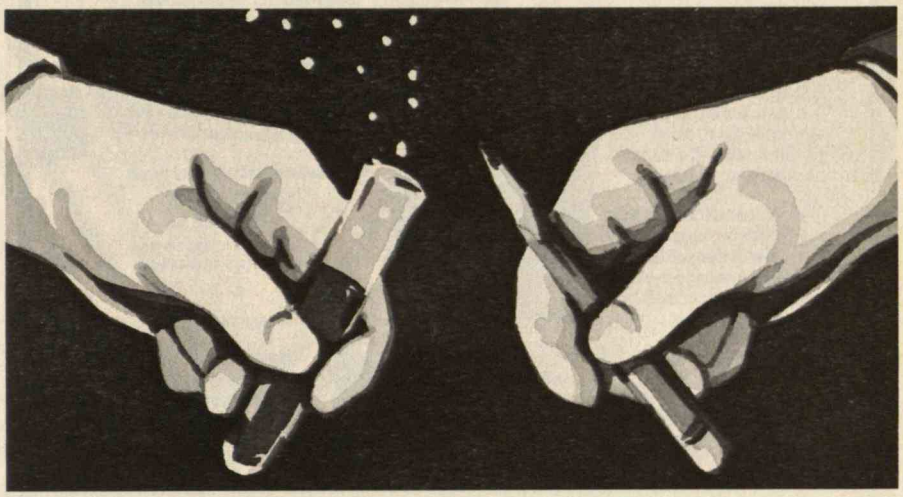
HYDROGEN may be the lightest of elements, but it seems to encourage some rather heavy hype. Hucksters' phrases abound as earnest researchers try to find cheaper, efficient ways to split the water molecule—preferably using energy from the sun—to obtain hydrogen for fuel. Thus, we hear of "the hydrogen economy," "abundant fuel from water" and, of course, the inevitable "scientific breakthrough." Such concepts may not be bad as ultimate goals. But things get out of hand when supposedly responsible scientists and, in at least one case, their university publicists mislead the public with suggestions that the ultimate may be just a decade or so away.

So it has been with the two water-splitting "breakthroughs" announced successively by scientists at the University of California, Berkeley, and Texas A & M University last September and October. As the gloss wore off the initial announcements, many of the researchers' scientific peers objected to what they considered overstatement—and these objections continue to reverberate. At the time, however, ever gullible news reporters dutifully wrote about and broadcast the glowing promises of electrolysis with "the first electrochemical cell that uses only sunlight and inexpensive chemicals."

This is the stuff of dreams and superficial news stories, but not of public understanding of this important research field.

The trouble began innocently enough with a report at an American Chemical Society (ACS) meeting of some interesting work by Gabor Somorjai, Minica Hendewerk, and Christofer Leygraf at the Lawrence Berkeley Laboratory. They were running an experimental photon-powered electrolytic cell in which the electrodes were essentially a pair of small disks fabricated from iron-oxide powder.

One disk was doped with an electron donor (silicon dioxide), the other with an electron acceptor (magnesium oxide). Cemented together with electrically conducting silver epoxy, the disks formed a diode that was suspended in a solution of sodium hydroxide or sodium sulfate. Hydrogen bubbled up at a rate of about 10^{15} molecules a minute from an active area of about 0.6 square centimenters when visible light shines into the cell. Over an eight-hour period, the efficiency of the magnesium-doped electrode dropped off. However, it was restored by bubbling air through the cell for ten minutes or so. In effect, the devices use photons to split water with an efficiency of 0.05 percent.



Taken on its scientific merits, this is a significant experiment. As Somorjai has pointed out, it suggests that a cheap material—doped iron oxide—may be used as electrolytic electrodes without the need for expensive catalysts such as platinum. But as Somorjai has noted, merely demonstrating that this is possible does not make the related engineering feasible, let alone economical.

For example, some electrochemists such as Bruce Parkinson of the Solar Energy Research Institute in Golden, Colo., worry about the need to regenerate the electrode every eight hours. Does this suggest future problems? Speculation about commercialization also seems decidedly premature in light of its 0.05 percent efficiency. *Science News* has quoted Dr. Parkinson as saying, "I think [Somorjai and colleagues] are making a big deal out of nothing."

Another Breakthrough Backfires

But most of the media had gone on to other stories by the time these experts were consulted, and the main public impression remained that scientists had taken a major step toward the "hydrogen economy." This led to further mischief. Down at Texas A & M, John Bockris, another leading electrochemist, felt that work proceeding in his laboratory deserved equal notoriety. Thus was born the second of the big "breakthrough" stories.

In Dr. Bockris's laboratory, Marek Szklarczyk (who left Warsaw University about a year ago) and Ali Q. Contractor are working with a photoelectric cell that uses silicon for electrodes. Illuminated by sunlight (more strictly, by a sun-simulating lamp), the system produces hydrogen with an overall efficiency variously reported at between 10 to 13 percent. To work, the system needs an electric potential across the two electrodes that is supplied by an external battery. However, the energy for splitting the water molecules comes mainly from the photons.

Here again, "sun-powered" electrolysis is possible with cheap electrodes. Furthermore, it proceeds at the highest efficiency yet claimed for photochemical cells. The trick lies partly in overcoming the inhibiting influence of the insulating film of silicon dioxide that forms when photosensitive silicon is immersed in water. This is where the proprietary aspect comes in, for the treatment of the anode has not yet been disclosed.

Again, taken on its scientific merits, this is a notable laboratory advance. But neither the press nor the public was allowed to take it on its merits. One could argue that the press ran away with the comments of Dr. Somorjai's group, although some other electrochemists think they overstated their case. Also, the Berkeley group followed professional custom of announcing their work at a scientific meeting. This coincided, more or less,

ROBERT C. COWEN is science editor of the *Christian Science Monitor* and former president of the National Association of Science Writers.

ILLUSTRATION: KATHERINE MAHONEY

with publication of the work in the September issue of the *Proceedings of the National Academy of Sciences*. But the Bochris group observed no such custom. It broke the news at what *New Scientist* described as a "hastily called press conference." It was subsequently reported that this had been inspired by the publicity given the Berkeley work.

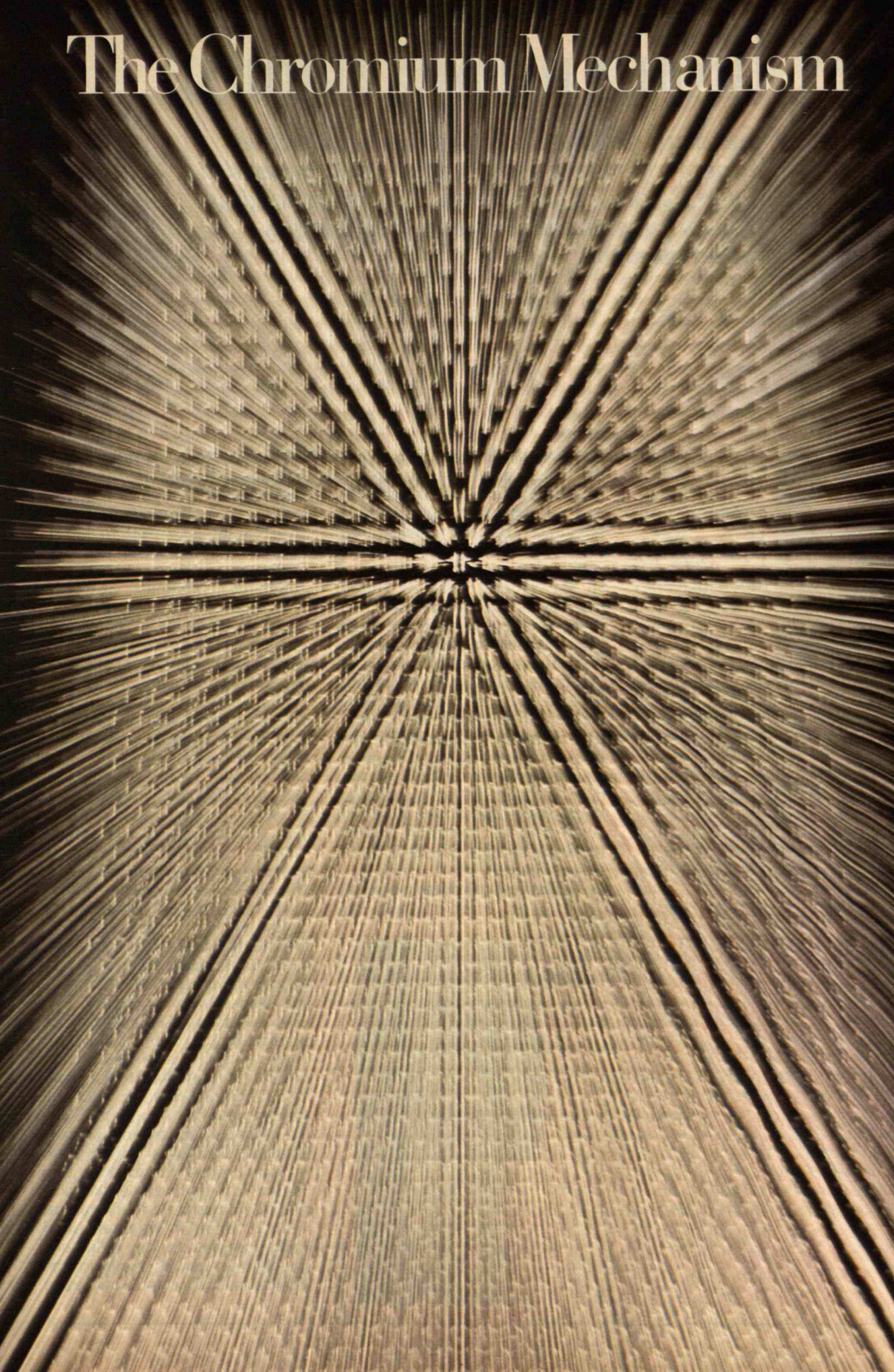
News reports from the press conference glowed with optimism. The relatively high efficiency of the cell was said to suggest that hydrogen fuel could be produced with a cost equivalent to $1-a-gallon gasoline. Moreover, this could come within a decade. These extravagent, indeed unsupportable, claims can be laid at the door of the publicity seekers no matter how much they may later claim to have been misunderstood. If other experts grumbled over the hype inspired by the Somorjai group's announcement, this time many were downright angry. *Chemical and Engineering News* reported a sharp reaction, in the face of which Dr. Bockris and the Texas A & M public-relations office backed off. They now emphasize the uncertainties and the engineering difficulties that lie between the dream of hydrogen fuel and its widespread use.

Does it really matter that the public was misled for a while? I think it does, both because the truth has a hard time catching up with fiction and because the hyperbole raises false expectations. But how are reporters to know when respected experts and institutions are leading them down the garden path? The peers of such scientists need to exert a little discipline, which happily they appear to be doing in this case.

Meanwhile, the basic aspects of the hydrogen-from-water story are worth keeping in mind. First, there is nothing yet in sight that fundamentally changes the economic analysis made three years ago by Derek P. Gregory, of the Institute of Gas Technology, and his associates. They concluded in part that "under today's conditions of price, hydrogen from gas and oil has an almost unbeatable cost advantage over any other source." They add, "Future hydrogen production from . . . various forms of solar energy is still not near commercial development." Second, no prophet of "the hydrogen economy" has yet come up with substantial reasons to doubt last year's projection of the International Energy Agency. Looking ahead 50 years, the agency concluded that the major user of hydrogen will be industry, not owners of private cars. Economics simply do not favor development of hydrogen fuel as a major energy carrier.

Perhaps future developments will change this. But until such facts are in hand, we could do with less hype. □

The Chromium Mechanism



The Chromium Mechanism

The first comprehensive explanation of electrochemical activity during the plating of chromium has recently been formulated at the General Motors Research Laboratories. This understanding has aided in transforming chromium plating into a highly efficient, high-speed operation.

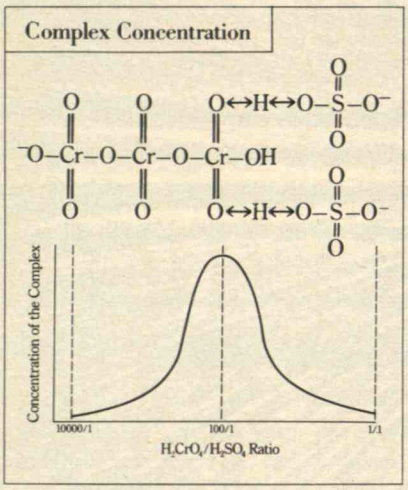


Figure 1: The electroactive complex and a theoretical plot of its concentration as a function of chromic acid to sulfuric acid ratio.

Figure 2: The electroactive complex diffuses from the bulk electrolyte solution (A) through the diffusion layer (B) to the Helmholtz double layer (C) to be discharged as metallic chromium (D) on the cathode (E) surface.

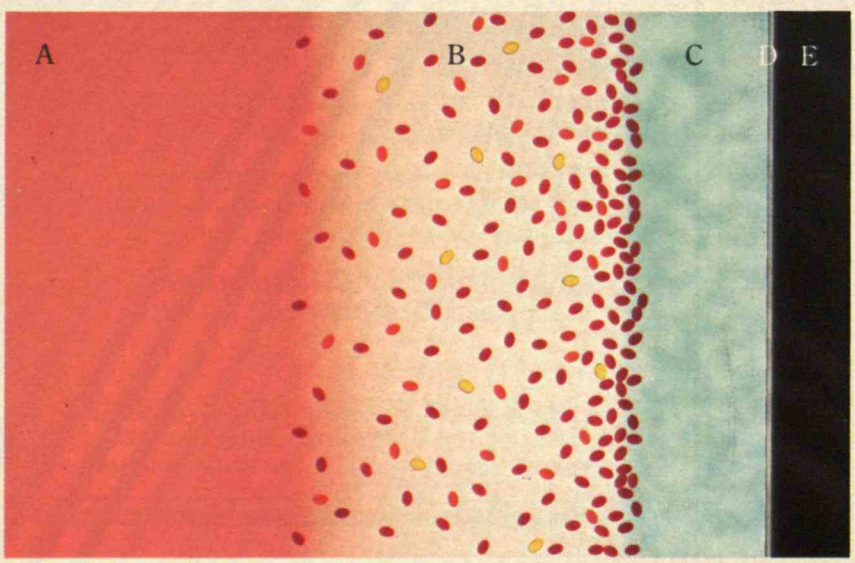
FOR MANY industrial applications, chromium coatings of more than 0.2 mil thickness are required for wear and corrosion resistance. But the conventional method of plating chromium is neither fast nor efficient. Nor, until the recent work of a GM researcher, had the steps involved in the century-old plating process been explained in detail. Through a combination of theory and experiment, Dr. James Hoare has devised the first comprehensive mechanism for chromium plating. This increased understanding has helped electrochemists at the General Motors Research Laboratories develop a system that plates chromium sixty times faster than the conventional method, while improving energy-efficiency by a factor of three.

The electrolyte for plating is a chromic acid solution which contains various chromate ions: chromate, dichromate and trichromate. From a series of steady-state polarization experiments, Dr. Hoare concluded that trichromate is the ion important in chromium deposition.

Sulfuric acid has been recognized as essential to chromium plating and has been assumed by some to be a catalyst for the process. In this strongly acidic solution, sulfate should be mostly present as the bisulfate ion $(HSO_4)^-$. Dr. Hoare found, contrary to expectations, that the addition of sulfuric acid to the plating bath decreased the conductivity of the solution.

Combining these findings with the results of previous investigations, Dr. Hoare concluded that the electroactive species was a trichromate-bisulfate complex (see Figure 1). From equilibrium considerations, he theorized that the maximum concentration of this species occurred at a 100-to-1 chromic acid/sulfuric acid ratio. The observation that the maximum rate of chromium deposition also occurred at this ratio supports the conclusion that this trichromate-bisulfate complex is the electroactive species.

During the plating process, the complex diffuses from the bulk solution toward the cathode (see Figure 2). Electron transport takes place by quantum mechanical tunneling through the potential energy barrier of the Helmholtz double layer and the unprotected chromium in the complex (Cr atom



on the left in Figure 1) loses electons by successive steps, going from Cr^{+6} to Cr^{+2}. Decomposition of the resulting chromous dichromate complex takes place by acid hydrolysis to form a chromous-oxybisulfate complex:

$$^{+}Cr-O\leftrightarrow H\leftrightarrow O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-O^{-}$$

The positive end of this complex is adsorbed onto the cathode surface. Electrons are transferred from the cathode to the adsorbed chromium ion, forming metallic chromium and regenerating the $(HSO_4)^-$ ion. Thus, Dr. Hoare's mechanism explains how sulfuric acid, in the form of the bisulfate ion, participates in the plating process.

IT HAS long been known that chromium cannot be plated from a solution when initially present as Cr^{+3} because of the formation of the stable aquo complex, $[Cr(H_2O)_6]^{+3}$. Yet chromium can be plated when initially present as Cr^{+6} even though it must pass through the Cr^{+3} state before being deposited. Dr. Hoare's mechanism handles this paradox by explaining that the chromium ion being deposited (on the left in Figure 1) is protected by the rest of the complex as it passes through the Cr^{+3} state, so that the stable aquo complex cannot form.

The diffusion of the electroactive complex apparently controls the rate of the process, so that shortening the diffusion path increases the speed of chromium deposition. A high rate of relative motion between the electrolyte and the cathode will shorten the path. This can be accomplished by rapid flow or by agitation of the electrolyte.

Dr. Hoare found that the rate of chromium deposition increased with electrolyte flow until the process was no longer diffusion-controlled. He also found that the use of dilute electrolyte significantly increased plating efficiency.

"This project is an excellent example," says Dr. Hoare, "of how basic research and engineering principles can be combined to develop a new, successful process. Now, we'd like to take on the challenge of plating successfully from Cr^{+3}, which would be an even more efficient way to provide corrosion and wear resistance."

THE MAN BEHIND THE WORK

Dr. James Hoare is a Research Fellow at the General Motors Research Laboratories. He is a member of the Electrochemistry Department.

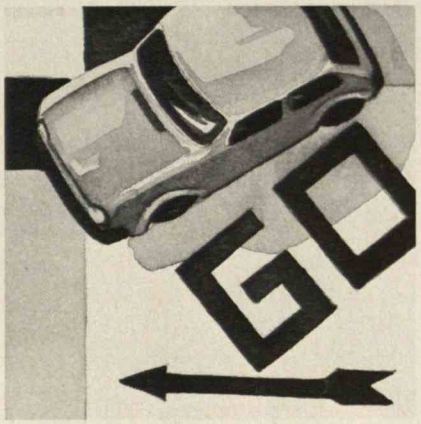
Dr. Hoare served as an electronics technician in the U.S. Navy during the Second World War. In 1949, he received his Ph.D. in physical chemistry from the Catholic University of America. After an assistant professorship at Trinity College in Washington, D.C., he joined the US Naval Research Laboratory as a physical chemist. He became a staff member at General Motors in 1960.

Dr. Hoare's sustaining interest has been in electrochemical kinetics and the mechanisms of electrode processes. He is best known to the scientific community for his basic studies of hydrogen and oxygen electrode mechanisms. His book, *The Electrochemistry of Oxygen*, published in 1968, is considered a work of primary importance to the field. In addition to his work on chromium plating, he is responsible for the fundamental research that helped make electrochemical machining a precision process.

Entrepreneurship Japanese-Style

Honda Motor: The Men, the Management, the Machine
by Tetsuo Sakiya
Kodansha International, 1982

Reviewed by Richard J. Samuels



Tetsuo Sakiya, a distinguished journalist and editor of the opinion-leading journal *Asahi Shimbun*, has written an extremely interesting book that serves to demystify as well as demythify Japan. He tells how, armed with little more than an idea for mass-producing machines, the two leaders of Honda proceeded alone, without official blessings of any sort, to design, assemble, and sell their product. Sakiya weaves into the Honda tale the roles of many institutions of Japan's complex political economy, including the general trading firms, the Ministry of International Trade and Industry (MITI), the banks, and Honda's competitors.

Takeo Fujisawa was the entrepreneurial and managerial genius behind Honda Motor Co. Failing the entrance examination to the prestigious Tokyo Higher Normal School in 1928, he had to settle for a job addressing envelopes prior to a short stint in the Imperial Army. His first taste of managerial autonomy and success came when he temporarily inherited a small steel trading firm after his employer was drafted for military service. Seizing his opportunity, he created an adjunct commercial operation in cutting and grinding tools for the war effort.

An inveterate tinkerer and the son of a blacksmith and bicycle repairer, Soichiro Honda arrived in Tokyo in 1922 at age 15 to become an apprentice in a small auto repair shop. The great Kanto earthquake the following year brought opportunities to the survivors, Honda among them, who could contribute to the rebuilding of the city. Honda did this by manufacturing piston rings for the large automakers while indulging in his passion for racing cars. At the end of World War II he sold his firm to Toyota, investing his capital in a rebuilt-engine business and later the production of motorcyles with Fujisawa.

We Americans are quite used to hearing of self-made individuals such as these. Indeed, their composite portrait has long served as the very model of American success. Japanese corporate annals are likewise replete with accounts of individuals such as Yatarō Iwasaki, the daring genius behind the Mitsubishi conglomerate. Yet observers always dismiss the Hondas, Fujisawas, and Iwasakis as atypical of postwar Japan. But they are ample evidence that Westerners' understanding of Japanese corporate structure and practice, not to mention business-government relations, is sorely in need of revision.

Cracking the Facade

A great strength of Japanese organization is supposedly the absence of charismatic leaders. Executives' effectiveness is said to be ensured by their anonymity and connections.

Not so with Honda and Fujisawa and not so with Honda Motor. This is the story of two men with no formal education at all. They had no *gakubatsu,* or university cliques, to mobilize and no assured access to the corridors of bureaucratic and industrial power.

The hardly benign neglect of Honda Motor by bankers and bureaucrats is also significant. Contrary to the rapturous harmony between Japanese government and industry Americans hear about, in case after case Honda Motor was denied access to credit by banks, access to foreign currency by the Finance Ministry, and, unsuccessfully, access to automobile markets by MITI. Fujisawa made end runs around bureaucrats and bankers and through the good offices of conservative politicians to exploit cracks in the facade of "Japan, Inc."

Creative financing such as advance cash payments enabled Honda Motor to finance growth through retained earnings rather than the extensive borrowing said to have contributed so much to Japan's economic advance. At the same time, Honda distinguished itself convincingly in the way it introduced and applied technology. Whereas most Japanese industry has judiciously adapted technology developed elsewhere for its own use, Honda has been the quintessential technology-driven firm. From its original incarnation as the Honda Technical Research Institute in 1946, the company has aimed at producing technologically advanced products rather than at the technologically advanced production of more common products.

For example, Honda was the first company to support research on enhancing engine power through more efficient fuel combustion. Honda produced the world's first scooter with polyester-resin components. The enormously popular "Dream E" motorcycle was the first equipped with an overhead valve engine in 1951, and the "Dream S" was the first to have an overhead camshaft system in 1955. Honda produced Japan's first front-wheel-drive vehicle and experimented with the ultimately unsuccessful air-cooled engines. The CVCC, or "compound vortex-controlled combustion," engine introduced in 1971 was perhaps Honda's greatest technological breakthrough, beating both foreign and domestic competition by years in the race for lower emissions levels.

To maximize such technological innovation, Fujisawa gave Honda's research labs full autonomy in 1960, allowing engineers to freely pursue basic concepts apart from the immediate constraints of the marketplace. The value of such indigenous technological development, or *jishu gijutsu*, has only lately emerged as MITI's priority for the Japanese nation as a whole.

Although Sakiya lacks the healthy skepticism one expects from the often antipathetic Japanese press, and occasionally relies too heavily on unsupportable cultural bromides, American readers can learn much from this book—even if it is only how much we have yet to learn from and about Japan. □

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ILLUSTRATION: KATHERINE MAHONEY

Treating Cancer with Heat

BY IRVING A. LERCH

As far back as Hippocrates, physicians have known about the healing powers of heat. But only recently have they begun to employ heat to destroy cancerous cells.

ALL life on earth shares one characteristic: its individual cells can survive only within a relatively narrow range of environmental conditions. While some living things thrive in the hottest gas vents in the deepest ocean chasms and others function in the Arctic tundra, once they are removed from their optimal environment, most organisms cease to be viable and die.

IRVING A. LERCH is a professor of radiology and head of Radiation Oncology Physics at New York University Medical Center.

Left: Physicians at Stanford University apply heat with an ultrasound device, which converts electrical energy into sonic waves. These high-powered sound waves can heat tumors deep within the body with greater ease and accuracy than other hyperthermia techniques.

Above: The beneficial effect of heat, as interpreted by photographer Thomas Norton in an image produced by a special color-synthesizing camera.

PHOTOGRAPH: STANFORD UNIVERSITY

Right: Hot water flows through an insulated suit, heating this patient's body to 107 degrees Fahrenheit. Since human tissues are relatively poor conductors of heat, this method is not as effective in killing tumors as newer electronic techniques.

Below: Microwave heating works best against tumors on the surface of the skin or just below. Here a gold-plated ceramic "horn" is used to apply heat to the site of disease.

Therapeutic medicine exploits this fact. Drugs that briefly alter cell physiology can wreak devastation not only on diseased tissue but on normal tissues as well. The great art of the physician is in knowing the limits of human endurance: when to suspend treatment so that the body will recover after the disease has been eradicated.

For the past ten years, a handful of medical research centers around the world have been experimenting with hyperthermia, a new form of cancer therapy that uses heat to manipulate the precarious balance of life. Hyperthermia alters the normal physiological environment of tumor cells, destroying their capacity to survive. But while heat produces devastating structural changes in tumors, the damage is slight or nonexistent in nearby healthy tissues. For reasons not completely understood, tumors seem to be more sensitive than normal tissue to the killing effects of heat.

This fact was first discovered in the modern era by a German physician, W. Busch, in 1886, but it was well-known to Hippocrates 4,000 years ago. In early Greek literature, Hippocrates extensively discussed the beneficial role of fever in

PHOTOGRAPHS: NATIONAL CANCER INSTITUTE AND RCA LABORATORIES

Above: Magnified 400 times in this photomicrograph, this densely packed human tumor thrives on nutrients supplied by the large blood vessel (the solid white part of the photo) that runs through its center. After hyperthermia treatment, the same tumor (top) is dying, its cells a mass of scarred tissue and its once healthy blood vessel shriveled and blocked off.

healing disease. Busch himself was astonished when a woman with a facial tumor spontaneously recovered after contracting a feverish infection. By the early twentieth century, an American doctor, William B. Coley, attempting to exploit Busch's discovery in the clinic, concocted a serum of bacterial fragments in an effort to induce fever. Coley's toxins continued to be used with mixed results until about 30 years ago.

Advances in modern technology have made it possible for physicians to experiment with hyperthermia with a more consistent outcome. One important finding of the experiments conducted so far is that heat therapy by itself does not achieve total cure in all cases. As a result, investigators view hyperthermia as a potentially powerful adjunct to standard treatments rather than as a miracle therapy or "magic bullet" against cancer.

Researchers have found that heat therapy improves the effectiveness of other forms of treatment such as radiation. While there is some improvement with heat alone, the combined treatment of radiation and heat therapy controls progression of the disease in 25 to 50 percent of the patients treated. This is all the more extraordinary considering these patients have failed to respond to previous treatment. Furthermore, healthy tissues exposed to both therapies at once appear better able to survive the combined onslaught than if equivalent doses of radiation or heat are applied separately. Thus, far more aggressive therapies are possible without subjecting the patient to an unacceptable increase in risk.

Cellular Armageddon

A small change in temperature can make a remarkable difference in the life or death of a cell. For example, cultures of the ovary cells of a Chinese hamster—a favorite target of cell biologists—thrive when maintained under conditions that mimic their normal physiological environment: neutral pH (neither acid nor caustic), adequate nutrients, proper salinity, and a temperature of about 37 degrees centigrade. However, when exposed to 43 degrees centigrade for only an hour, from 50 to 90 percent are destroyed. But this is not a simple phenomenon. Lowering the temperature to 42 degrees centigrade radically alters the outcome: between 80 and 90 percent of the treated cells survive. A single degree separates cellular Armageddon from survival; the mechanics for thermal killing are exquisitely sensitive.

Another complicating factor is that cells have adaptive equipment. When the ovary cells of Chinese hamsters are exposed to 42.5 degrees centigrade for periods of increasing duration, the rate of cell killing is initially constant: each succeeding exposure destroys the same percentage of living cells—roughly 90 percent after 80 minutes. But for exposures in excess of 300 minutes, the rate of killing drops precipitously, as if the remaining cells had acquired a tolerance for heat. Indeed, cells may be purposely conditioned by promoting this thermotolerance with a short pretreatment of heat followed by the normal killing exposure. A clear understanding of this cellular phenomenon is critical if the clinical application of hyperthermia is to succeed.

The Potent Effects of Heat

There is considerable controversy among researchers about what actually happens at the molecular level when cell cultures are exposed to heat. Some believe it inhibits glycolosis, the vital breakdown of glucose to form lactic acid. However, many cells do not experience this effect.

PHOTOGRAPHS: F. KRISTIAN STORM, UCLA MEDICAL CENTER

Within tumors, it appears that blood circulation is generally more sluggish than in normal healthy tissue. While blood flow in disease-free areas actually increases in an effort to flush out excess heat and cool the cells down, blood slows down in heat-treated tumor cells. As the blood flow in the tumor continues to decline, vital nutrients and oxygen are withheld from the tissues until they begin to die and break apart. Some scientists believe that fragments from dying tumor cells may escape into the blood stream and stimulate the immune response that leads to hyperthermia cures. There have been unconfirmed reports that advanced cancers have vanished in patients who received treatment at only one disease site.

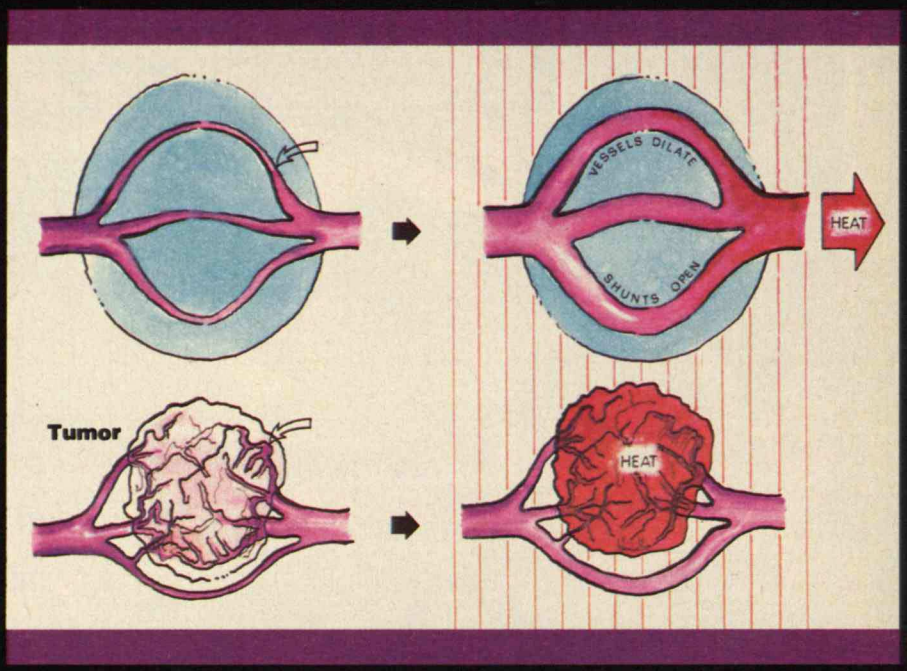
Cellular studies also reveal that changes in the membranes of heat-treated cells may make them more permeable to certain proteins. Once these proteins gain entry, they could suppress or alter the complex array of biochemical signals responsible for molecular biosynthesis and cell reproduction.

While it is not clear exactly which biochemical processes heat therapy affects, researchers do agree that variations in cellular pH, oxygen concentration, and glucose supply all profoundly alter the heated cell's chance of survival. By properly manipulating these factors in treated tissues, it may be possible to protect normal cells while sensitizing the tumor to treatment.

The synergistic coupling of heat, radiation, and drugs was no surprise to investigators who pioneered in thermobiology. Experimenters knew that cellular respiration changed during heat therapy—that oxygen-starved cells were more likely to succumb to treatment than cells provided with a good oxygen supply.

The reverse is true for cultures exposed to radiation. Cells rich in oxygen are more sensitive to radiation because the radiation reacts with water molecules to produce energetic free radicals (atoms energized with an extra electron). And these, in the presence of oxygen, produce poisons such as hydrogen peroxide. Without oxygen, fewer toxins are produced, increasing the cell's chances for survival. The failure of some radiotherapy is attributed to the fact that many solid tumors outgrow their blood supply, making them oxygen-deficient—or hypoxic—at their peripheries and thus radioresistant.

Since heat is particularly effective against hypoxic cells, researchers concluded it would complement radiotherapy. In fact, the two forms of therapy are more than complementary; they are synergistic—they appear to amplify their mutual impact on the treated cells. This may be due to the fact that heat inhibits the molecular and cellular mechanisms that would normally repair sublethal radiation damage and aid cell recovery. Similar phenomena are found when hyperthermia is combined with other treatments such as radiosensitizing drugs and chemotherapeutic agents.



Why cancer cells are more sensitive to heat than normal cells is still a matter of conjecture. One theory, as illustrated in this diagram, is that the vasculature (the structural web of blood vessels) inside tumor cells is not as efficient as the vasculature inside normal cells. When a normal cell is heated, its blood vessels dilate, increasing blood flow and flushing out the excess heat. But the intertwined vessels in a tumor cell are unable to get rid of heat in this manner and blood flow slows down. As a result, the tumor cell is deprived of vital nutrients and eventually dies.

Of Tumors, Mice, and Men

As the temperature is raised in animal tumor systems, researchers report an initial increase and then a rapid decrease in respiration. They detect a marked response when the tumors are heated to 42 to 43 degrees centigrade that is surprisingly similar to the results obtained with cell cultures. While the tumor may continue to grow for a few weeks after treatment, the rate of growth is less than that of the untreated control tumors. The tumor then begins to shrink and usually vanishes about five weeks after heat is applied. Interestingly, tumors are less apt to survive if the heat is applied locally rather than over the whole body. However, scientists have been attracted to the idea of whole-body hyperthermia because of the possibility that cells that have spread to distant parts of the body might be killed by such treatment. While early results with whole-body hyperthermia were conflicting, recent reports from the Mississippi Cancer Center in Jackson indicate some room for optimism.

Part of the renewed interest in heat as a cancer treatment is due to advances in technology that have furnished the medical community with a large and varied array of instruments capable of heating tissues selectively. Other advances, such as in electronic thermometry, miniature thermocouple, and fluorometry probes, make it possible to accurately measure the temperatures of heated tissues, a vital prerequisite for treatment.

The goal is to heat tissues discriminately—to define a treatment area and to spare everything outside the diseased region. The area must be heated uniformly at a precise rate to a target temperature

and maintained at that temperature for a specific time interval. And the method must not cause undue discomfort to the patient during or after therapy.

One of the most popular technologies uses the body itself as part of an electrical circuit. Since tissues are only fair conductors, they will readily dissipate energy in the form of heat. Thus, applied current (or capacitive heating) is rather simple, requiring two electrodes powered from a radiofrequency amplifier. The electrodes are placed across the mass of tissue to be heated. If the abdomen is the site to be heated, for instance, an electrode is placed on each side of the body. An electric field then connects the two electrodes through the tissue, and the current follows the path defined by the electric field.

A difficulty with this method is that the current traces a path of least resistance and often fails to uniformly heat a heterogeneous mass of tissue. Much of the heat is dissipated in the skin and underlying fat, requiring the use of a cooling circuit to prevent burning. To make heating more uniform, additional electrodes must be applied in sequenced intervals around the body during treatment. This provides numerous pathways for the current, all intersecting at approximately the center of the therapy field. Unfortunately, this makes the treatment somewhat cumbersome and increases the complexity and cost of the equipment. And experimenters still cannot be certain that the targeted area is being uniformly heated.

Another strategy is to deliver the radiofrequency energy with a flat, pancake-shaped coil made of a few turns of copper tubing. The coil produces alternating electric and magnetic fields in the exposed tissue. Superficial heating of skin and underlying layers is due to the electric component of the field. Deeper heating is induced by eddy currents generated by the magnetic component of the field. The larger the coil, the deeper the electric field penetrates. In this case, a single electrode may be used.

Since the heating is not uniform across the face of the coil—it is cooler in the center than at the perimeter—it is necessary to move the coil during therapy or to design multiple electrodes. One bonus of the technique is that magnetic material that couples with the coil's electromagnetic field may be implanted in the treated tissue in the form of needles or seeds. The implanted material can heat the surrounding tissue without damaging the skin or its fatty sublayer. Researchers have designed many different kinds of coils, such as large cylindrical tubes that encircle the portion of the patient's body that requires heating.

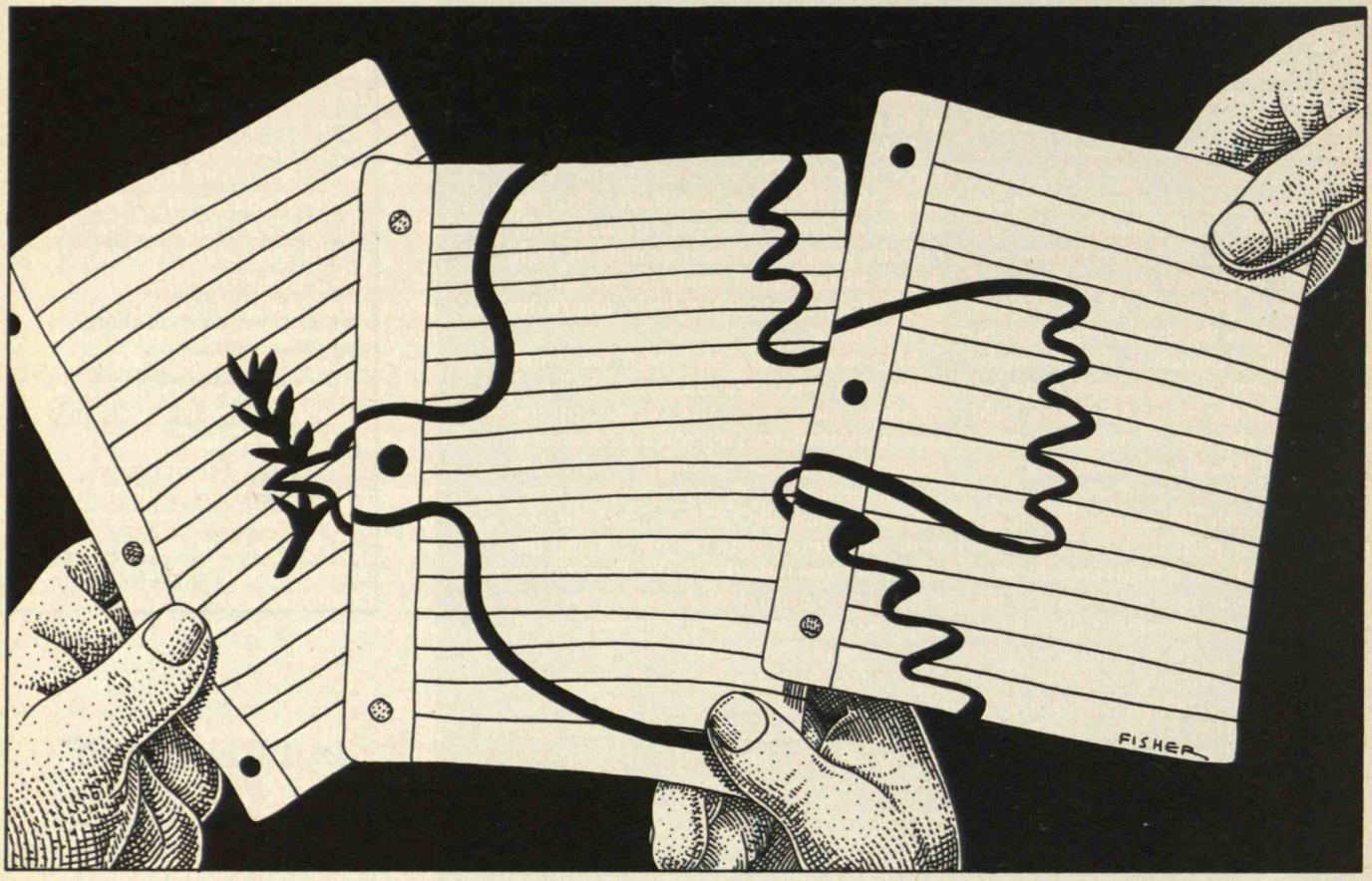
A few investigators are also seeking ways to infiltrate diseased tissue with drugs that contain liquid-paste mixtures of ferromagnetic material. If successful, radiofrequency induction heating of such doped tissues could eradicate tumors in single treatments with little injury to nearby tissue.

Microwaves have also been used and found very effective in heating "shallow" tumors—those near the surface of the skin. Unfortunately, microwaves deposit a tremendous amount of energy in the skin and sometimes in the fatty layer. Therefore, care must be taken to cool the patient and protect both the patient and the operator from radiation leaks. Penetration has been improved by lowering the frequency of the microwave radiation, but at the cost of projecting ill-defined fields. It is very difficult to focus and shape microwaves, although new and ingenious solutions are continually being proposed.

Ultrasound transducers—devices that convert electrical energy into sonic waves—can also be used to generate heat when driven at high power levels. It appears that high-energy sound waves may be focused on a deep tumor, such as one in the prostate or cervix, with greater ease and accuracy than any of the other technologies and without undue heating of the surrounding tissues. However, serious drawbacks include uneven heating in the bone and loss of energy in the air, making the method unsuitable for heating lungs or gas-filled bowels. And some patients experience pain when bone is in the field of treatment because bone, being a good conductor of sonic waves, absorbs excess energy.

The hyperthermia techniques now available all have flaws. But technological advances should eventually provide us with more consistently successful methods. Even now, hyperthermia has the potential of helping the approximately 200,000 patients who fail to respond adequately to radiation treatment each year. This means that as many as 50,000 patients or more could be saved in the United States alone. And should hyperthermia prove as effective when used with chemotherapy and surgery, many more lives could be saved. □

The Nuclear Arms Race: Views from Three Professions



1. The Psychology of War and Peace

by Judd Marmor

THE shadow of nuclear annihilation hangs over humankind, a nightmarish outgrowth of the political, economic, and ideological issues that separate the United States and the Soviet Union. These issues are formidable, complex, and real—but behind them lie fundamental psychological factors that seriously hinder development of rational and nonviolent solutions.

It has been claimed that aggression is so inexorably a part of human nature that all talk of eliminating war must be relegated to wishful thinking. In fact, most behaviorial scientists now believe that violence is not a spontaneous instinct, but rather a response to frustration or perceived threats to psychological or physical security. They do not deny that the *capacity* for violence is innate, but they assert that whether this capacity is *expressed* generally depends on external factors.

Even if aggression were innate, it still would not follow that wars are inevitable. The pushbutton computerized nature of nuclear weaponry has made anger and aggression not only unnecessary but actually detrimental. These weapons require calm, mathematical precision, not passion. In addition, modern war is a complicated social institution that has evolved and changed enormously over the centuries. Waging war now requires sophisticated technology, awesome amounts of human and material resources, and elaborate organization. Therefore, war as a social institution—like slavery, dueling, and ritual human sacrifice, which in their times were also considered to be deeply rooted in human nature—is potentially eradicable.

Perhaps the most serious psychological factor standing in the way of such eradication is the mutual distortion of perception that occurs between nations in conflict. This is known as ethnocentric perception—that is, the tendency of members of a group to perceive and evaluate events based on their own interests and beliefs. The virtues of one's own side are

ILLUSTRATIONS: MARK FISHER

magnified and its faults not seen, while an adversary's "evils" are exaggerated and its virtues ignored.

This leads to stereotyped conceptions on each side. The motives of one's own group are seen as honorable, fair, and decent, while those of the opposing group are suspect. For example, behavior that is perceived as "standing firm" when exhibited by a member of one's own group is interpreted as "being pigheaded" when manifested by others. Similarities among groups go unnoticed or are minimized, while differences are exaggerated. Such polarization leads each side to see the other as untrustworthy and threatening, heightening the fear and insecurity on both sides.

This fear greatly increases the probability that overtly hostile acts will occur. Fear is a basic biological reaction; without fear, individuals might not take the proper actions needed for survival in the face of danger. Unfortunately, only a thin line separates the amount of fear that stimulates corrective behavior and the amount that leads to destructive actions. Psychologists describe a phenomenon that they call the "primitivizing effect of fear." This means that human reactions, like those of animals, tend to become more archaic and less rational under conditions of extreme fear or panic.

Thus, when national leaders fan public fears of an adversary to great heights—and the media are often responsible, too—they create unbearable tension in many people. This tension seeks relief at almost any cost. People may come to see any action as better than none at all, and the certainties of war may appear more tolerable than the ambiguities of peace.

Fear also shortens people's time perspective. A fearful person becomes preoccupied with warding off what is sensed as immediate danger, with little concern for the ultimate consequences of his or her reactions. Similarly, nations may counter what they perceive to be an imminent threat with actions having long-term effects that may be much more serious than the initial hazard.

Under such conditions, people tend to "dehumanize" the adversary. This makes the fears and paranoid distortions seem even more justified. By reducing adversaries to a less-than-human status, it is easier to rationalize not only denying them human rights but also killing them with little compunction.

Such psychological distortions inevitably lead to biased perceptions of what is fair and reasonable, making meaningful negotiations difficult or impossible. Deep suspicion becomes a major barrier to the nonviolent resolution of conflicts. The expectation that no agreement can be reached because the other side "cannot be trusted" too often becomes a self-fulfilling prophecy.

Politicians sometimes deliberately encourage distortions of an adversary's goals and actions. They may withhold significant information or spread false information to achieve what they consider strategic objectives in the power struggle with the adversary. Also, leaders often say things that are intended only for domestic consumption and that represent maneuvers in their political game plans. But such statements lend themselves to misinterpretation and can generate tension, fear, and hostility in the public.

This interplay captures both leaders and public in a vicious cycle of increasing psychological tensions and misunderstandings. Thus, even when leaders may wish to make realistic compromises, they may be hampered by nationalistic expectations, political expediency, pressure of power blocs within their own country, and the aroused public's fears and suspicions. And if leaders nevertheless make such efforts, they are often subject to charges of betrayal. The reaction of the Arab world to Egyptian President Sadat's heroic attempt to engineer a peaceful solution to Middle East conflicts provides a case in point.

Heads in the Sand

Another psychological reaction that plays an important role in the way people respond to the threat of nuclear war is denial. This is the nonrecognition of certain realities in order to cope with the feelings of fear and personal helplessness that those realities would otherwise engender. It is an appropriate reaction to sources of anxiety that cannot be controlled, such as the inevitability of one's own death, but it is maladaptive when threats *can* be dealt with. Thus, to ignore the threat of nuclear destruction as if it were nonexistent exposes us to the danger that it will happen.

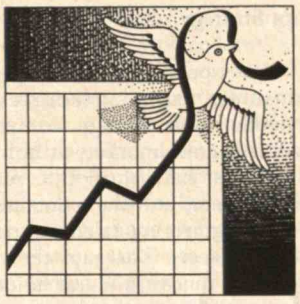
Indeed, many people cling to the "myth of invulnerability" in the face of life-threatening situations. The idea that "it

(Continued on page 24)

2.

Business Deals with the Soviets

by Alan F. Kay



CALVIN Coolidge was right when he said that "the business of America is business." From tycoons to farmers, shopkeepers to consultants, businesspeople plan, develop, and operate countless successful enterprises. These businesses must be highly versatile to survive. They employ a diversity of people and must supply a great variety of goods and services to meet customers' needs. Compared with the business community, the politicians and military leaders who plan and carry out U.S. defense policies constitute a much narrower group with far less collective experience in the real world.

Indeed, the effectiveness of policies to contain communism during the last three decades—in Cuba and Vietnam, in particular—is questionable. Despite enormous U.S. effort, these countries have emerged as virulently pro-Soviet and anti-American. On the other hand, the People's Republic of China and Indonesia, where the United States was unable to exert much influence after they were absorbed into the Soviet sphere, in time threw out their Soviet "friends" and started to return to a measure of capitalism.

The lesson from these costly losses and "free" gains is that U.S. military intervention seldom does this country any net good—perhaps never any lasting good—and often does enormous harm. (The same is true of the Soviet Union's military

interventions.) Yet we watch our politicians, who are no worse than politicians in any country, pursue military buildup energetically. The relatively tiny portion of the federal budget allotted to arms-control efforts reflects the current philosophy of peace through strength. The United States has never considered arms-control measures that do not at least maintain and preferably enhance its military might relative to adversaries.

Bankrupt Strategy

Many businesspeople see how the arms race consumes capital, resources, and human skills while foreign competitors take over consumer markets at home and abroad. Almost half of all U.S. research and development, and the associated scientific and engineering talent, is devoted to military projects. This saps the vitality of commercial innovation and hinders investment in civilian technologies, stifling the nation's economic growth and reducing productivity growth.

The Council on Economic Priorities, a nonprofit public-interest research group in New York, recently compared the economic performances of 13 major industrial nations over the last 20 years. It concluded that "those countries that spent a smaller share of their economic output on the military generally experienced faster growth, greater investment, and higher productivity increases. Those that carried a heavier military burden, like the U.S., had poorer economic performance."

Indeed, the United States spent the highest percentage of its domestic economic output on defense (7.4 percent) among the 13 nations but ranked eleventh in overall growth and last in productivity gain. This is partly because the United States ranked last in capital formation. That is, U.S. industry invested the lowest share of economic output in more efficient plants and equipment to improve its competitiveness and long-term growth.

In addition, many economists contend that military expenditures are basically inflationary because defense products do not contribute to consumers' living standards. The recipients of defense dollars also go into the nondefense marketplace for goods and services and can pay top dollar to compete with the rest of the business community.

The Department of Defense counters such criticisms by saying that Pentagon spending creates new jobs, but this is misleading. The Council on Economic Priorities has estimated how many jobs would be created by spending $1 billion on developing the MX missile system compared with spending it in various civilian areas. Military spending would provide 53,248 direct and indirect jobs. But the same $1 billion could produce 77,356 jobs in mass transit, 64,859 in public utilities, 54,235 in solar energy, 54,220 in railroads, and 68,859 in housing.

This is clearly a bankrupt strategy. In business, when a strategy continues to fail, at some point we must cut losses. And the most successful businesspeople usually cut losses quickest. But politicians, seemingly unable to learn from mistakes, make a virtue of obstinancy. They call it "staying the course" or "steadfastness."

Businesspeople generally admire the military ethic: "For victory, whatever self-sacrifice is required." But we now see that this spirit can no longer guide the course of U.S. military and foreign policy. At best, it is exceedingly wasteful; at worst, it implies the potential "necessity" for sacrificing millions of people and destroying our society in a nuclear war. With the increasing arsenal of nuclear weapons on both sides, war finally seems too important to leave to the generals *and* to the politicians.

Business Lessons

People running businesses have long experience in dealing both cooperatively and competitively with others. This experience ranges from bargaining with vendors and employees to negotiating complex agreements in the realm of national and international trade. One lesson we've learned is that "parity," much less superiority, is not required for successful negotiation. Deals are jeopardized if force is seen as a potential threat of either party.

This holds true when it comes to doing business with the Russians. A good illustration is the success of Armand Hammer, chief executive officer of Occidental Petroleum. For more than 60 years he has negotiated a variety of very profitable commercial projects in the Soviet Union. And neither he, nor others such as industrialists Cyrus Eaton and David Karr, have ever given away the store.

This doesn't mean that capitalists should sell communists the rope by which we will be hung. Some restrictions on trade with the Soviet Union may be appropriate. However, it's important to remember that the Soviets import from the United States only about one-tenth the advanced machinery and equipment that they import from Europe and Japan. Indeed, they can manufacture or obtain from other nations all the technology and hardware that have prompted some people, including the president, to talk about "Soviet military superiority."

Thus, any government controls on trade with the Soviet Union should be established only after the consequences have been weighed fully, not on the basis of short-term political concerns. For example, consider the question of whether to prohibit the sale of sophisticated, ultrareliable computers to the Soviet Union, especially if we know that they can be used in strategic-weapons systems. Many people would immediately say, "Of course, stop them." But suppose we also know that the computers would make it less likely that Soviet forces would mistake a flock of geese for U.S. bombers and so would be less likely to launch irretrievable missiles. The answer is not so obvious. For reasons such as these, the best strategy for maintaining national security is to ensure that U.S. industries—backed by strong science and technology programs—remain good innovators.

Seeking the Best Deal

Doing business with the Soviet Union will directly benefit the United States as well. Every businessperson knows that two parties agree to a deal only when both sides stand to gain. But politicians latch onto peculiar ideas. For example, in the past they have opposed the sale of U.S. grain to the Soviets and the purchase of Soviet natural gas by Western nations in the name of "punishing" the Soviets. However, if the transactions could be freely negotiated by businesspeople seeking the "best" deal, both East and West would fare equally well.

In fact, if the economies of the superpowers came to rely more heavily on such trade, the two nations would be less likely to pursue antagonistic courses. To politicians, this might make it seem as if the United States were losing its "self-sufficiency." But those in the business community seldom seek self-sufficiency. Since we constantly buy materials and

labor from someone and sell our products and services to someone else, total independence is neither possible nor desirable.

Researchers have developed various theories to explain why political negotiations between the United States and the Soviet Union so often prove fruitless, and they suggest some approaches that might be more successful. (*See "To Gain a Peace in the Nuclear Age," April 1981.*) They have found that there is a great difference between the attitude of most business negotiators and that of typical political negotiators, although many of the latter have been impressive and competent people. For example, business negotiators try to address the real interests of both sides, not just their stated positions. They are free to make whatever deals they consider advantageous, and they avoid linking conflicting interests that are so complex as to preclude resolution.

The superpowers should devote their resources to strengthening their best alternatives to a deal being negotiated, and not take action designed to frighten the other side into agreement. Negotiations could be guided by "brokers," a concept almost unknown in international relations. That this is possible is demonstrated by the Camp David accords, in which President Carter helped Israel and the Arab nations in their peace-seeking efforts. The challenge will be to identify individuals who have the experience and stature to broker U.S.-Soviet negotiations.

The fundamental concern, of course, is that certain devastation would result from nuclear war. Such waste violates the business community's commitment to managing property and assets prudently. How can we play the game—how can we strive for profits to benefit ourselves and our families and rise to the top of the business pyramid—when nuclear war threatens to turn these goals into ashes?

Business could not function in the civil disorder that would result from nuclear war. This means the business community must rise above its usual horizon of this quarter's profits. We must begin to apply the skills gained in competing and cooperating with others to help reduce the looming possibility of nuclear war. □

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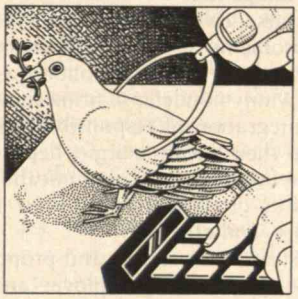
3. The Perils of Defense Employment

by Warren F. Davis



WHEN the Soviet Union launched its first Sputnik in 1957, the effect on American attitudes was immediate and profound. I was then an aspiring scientist in my junior year of high school, and I found myself on a fast track into the defense industry. And many others like me were similarly mobilized to give the United States a "shot in the arm."

Today, we are again reacting to a perceived Soviet technological challenge. But while the launching of Sputnik was undeniable, current allegations of Soviet superiority are much more difficult to substantiate. Yet the effect on young scientists and engineers will likely be the same: it will be very difficult for new graduates to avoid employment in the defense industries.

While there are clear moral grounds for refusing to participate in weapons-related work, there is also a more immediate and pragmatic issue: defense employment may be dangerous to the long-term health of a young technologist's career.

Secrecy Breeds Overspecialization

Nearly all defense work is done under the mantle of secrecy, and obtaining a security clearance is a prerequisite for employment. It is a distasteful process, but the more troubling consequences of secrecy begin when the clearance has been obtained.

Secrecy is imposed in the defense environment to protect national security. Whether it achieves this goal is a matter of debate. But secrecy in defense work does protect the corporate structure by establishing a strong hierarchy within the company. The standard test of what you are permitted to know is your "need to know." You do not have access to classified information, though it may pertain to the project on which you are working, unless it is essential for the direct discharge of your responsibilities. This concept is often extended to the application of the product—the device or system—as well. You might never know into whose hands it is ultimately placed and for what purpose.

The advantage to company management is that project responsibilities become highly compartmentalized and easier to coordinate. For the individual, unfortunately, it means a loss of influence and control. Without overall knowledge, employees are simply not in a position to criticize company policy or help to direct it toward more personally rewarding or socially redeeming goals.

The individual pays the price with more than a loss of influence. Far worse, in the long run, is the fact that compartmentalization leads directly to overspecialization. You tend to become an expert in a very narrowly defined area, while your other skills atrophy or become obsolete. And while overspecialization would seem to be disadvantageous to the company as well as the individual, it is not.

In general, defense contracts last only a few years; projects come to an end. Of course, the company may acquire another in the meantime that can use your now very specialized skills. But if the company has no such contract on hand, you become a liability and are likely to be laid off.

Why would the company prefer to lay off a skilled employee in such a case? Doesn't the specialization you have acquired represent a substantial investment? It does, as long as the company can utilize those skills directly. But if your specialization is no longer required, the company has the choice of retraining you or training a new graduate. It will often opt for the latter. His or her salary will be substantially less than yours; his or her formal training in a rapidly advancing technology will probably be a good deal more current; he or she will probably not have the personal responsibilities you have probably begun to acquire and thus can relocate more readily; and given the graduate's excitement in the first-job situation,

he or she may actually work harder than you. This propensity for hiring through one door while firing through another is common in the defense establishment.

No Transfer

What is the outlook if you thus find yourself out of a job? Reemployment within the defense industry is made difficult by your overspecialization. There are likely to be only a few companies competing for the available contracts in any particular field. Thus, the number of companies requiring your specialty is limited, forcing you to seek employment in the civilian sector. But nondefense employers may be reluctant to hire you.

Your overspecialization may have caused you to fall behind in the broader aspects of your profession. The secrecy imposed on your work may have prevented you from publishing much in the open literature. Similarly, you may have been limited in what you could discuss at trade shows and conferences. You may even be restricted in what you can tell a prospective employer about your former work.

In general, defense employees receive higher salaries than their civilian-sector counterparts. Nondefense employers may be unable to meet the salary standards to which you have become accustomed. They may be unwilling to hire you because they see themselves as a way-station between higher-paying defense jobs, and they may be unwilling to pick up the tab for the retraining and updating that might make you valuable again in defense.

Moreover, the skills acquired in a military environment may not be readily marketable in the civilian sector. Weapons systems must be designed and built to function under the extreme conditions of battle. Thus, defense products are highly specialized and must have a low failure rate. They often require a large investment in research and development for a relatively limited production run. And defense firms face limited competition, often operate on a cost-plus-fixed-fee basis, and have government bureaucracy as their customer.

In contrast, products for the civilian market must be low-cost, function within a better-defined and far less hostile environment, and be produced in large volume. Profit cannot simply be added on as a fixed fraction of an indefinitely large research and development budget. Skills that are valuable in the defense industry are often inappropriate and difficult to market in the civilian sector where cost-effectiveness is paramount. In fact, because it is frequently so difficult for engineers from a defense firm to move into a position with a commercial company, many are forced to drop out of the profession altogether.

Of course, civilian industry also experiences problems of overspecialization and rapid employee turnover, but to a lesser extent. Many nondefense firms encourage more integration of responsibility simply because their profit margin depends on the benefits of open communication: innovation, cross-fertilization of ideas, creativity, and efficiency.

Industrial trade secrets and proprietary agreements (between employer and employee) exist as well. But researchers are generally free to explore all potentially fruitful paths within the boundaries of the company, and proprietary agreements are usually negotiated by the parties concerned. In some cases, they expire automatically soon after cessation of employment.

The problems of moving out of the defense industry into civilian employment are exacerbated by the cyclical nature of defense procurement. Markets in defense technology and research are artificial. They are often based on political perceptions, such as the need to "send messages of resolve" to the enemy, rather than on demonstrable military need. Historically, such perceptions have swung back and forth like a pendulum with shifts in administrations and public opinion. As a consequence, the number of defense jobs has exhibited a correspondingly cyclical pattern.

A sudden contraction or shift in defense procurement affects whole companies as well as many individuals. Small firms dependent on defense contracts often simply disappear. Although recessions also affect the civilian sector, their onset is usually not so abrupt or arbitrary. In contrast to the defense business, civilian industry depends on real, permanent markets.

The best way for a young technologist to avoid such career pitfalls, of course, is to avoid the defense industry from the start. Most of the skills required in work on weapons systems have important potential applications in the civilian sector and could be used to address urgent social needs. Redirection of government priorities into these areas would improve the sagging U.S. competitive position in domestic and foreign markets and begin to lead the world away from the brink of nuclear catastrophe. □

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MARMOR/CONTINUED FROM PAGE 21

won't happen to me (or us)"—that somehow we will be among the survivors—is a dangerous and pervasive illusion. And it is perhaps fortified by the fact that most Americans have never personally experienced the horrors of war.

A major element in the denial mechanism is our inability to conceptualize the magnitude of a danger that is totally beyond human experience. People understand what 100 degrees Centigrade means because we have all experienced the heat of boiling water, but the meaning of 15 million degrees generated by a "small" atomic explosion is simply beyond comprehension. And even if we have a faint idea of the power of the bomb dropped on Hiroshima, we cannot conceptualize the destructive power of a modern bomb that is 6,000 times more powerful.

At still another level, there may be an intellectual awareness of the danger of nuclear weapons, but the feelings appropriate to such awareness are absent. The physicist Albert Szent-Gyorgi put it well: "I am deeply moved if I see a man suffering and would risk my life for him. Then I talk impersonally about the possible pulverization of our big cities, with a hundred million dead. I am unable to multiply one man's suffering by a hundred million."

Even our language is inadequate for characterizing nuclear phenomena. New words such as "megaton" lack emotional impact because they do not refer to actual experience, and old words can engender a

false sense of security. The word "war" itself, when used in relation to nuclear destruction, is totally misleading—such an event would have no resemblance to traditional warfare. "Civil defense" and "national security" also arouse reassuring images even though their meanings have been drastically altered by the power of nuclear weaponry. What's more, the proliferation of nuclear jargon—for example, MIRVs instead of bombs—only obscures the visceral impact.

Closely related to denial, and equally maladaptive, is the habituation and desensitization that occurs when "the possibility" of nuclear warfare is frequently discussed by military and political leaders. The unthinkable becomes thinkable. People find themselves speculating about nuclear war as if it were simply another kind of conventional warfare, and about nuclear warheads as if they were just a larger variety of conventional bombs. First-strike strategies are discussed in terms of "victory" rather than the total destruction of civilization.

What, then, can individuals do to cope with the nuclear threat? Confronting the danger and becoming involved in protests against the arms race—as hundreds of thousands of people in Europe, and now in the United States, are beginning to do—can help overcome the sense of personal helplessness that contributes to fear and denial. The power of such protest when it takes place on a large scale should not be underestimated—witness the fact that widespread public repudiation of U.S. involvement in Vietnam played a significant role in bringing that unhappy project to an end.

Needed: International Cooperation

We also face a more fundamental task. Albert Einstein pointed out that "a substantially new manner of thinking" is needed if mankind is to survive the "unleashed power of the atom." This must include an alteration in our traditional way of thinking about international conflicts. To see them as struggles in which the only possible outcome is total victory for one side and total defeat for the other makes it impossible to envision constructive alternatives. We need to recognize that international conflicts can be truly resolved only by solutions in which both sides stand to gain. Arms-control treaties and a nuclear-weapons freeze represent such solutions, both economically and in terms of mutual national security.

The central need, of course, is for both sides to accept the necessity for coexistence. We know that after almost a millennium of futile and bloody religious violence, Christianity and Islam gave up efforts to destroy each other—despite occasional isolated flareups in the Middle East—to their mutual benefit. Today, however, the rampant buildup and spread of nuclear weaponry no longer provides such a cushion of time. It is imperative that we find solutions other than war to the conflicts among nations.

In fact, behavioral scientists have seen that mutually beneficial solutions to intergroup conflicts often markedly strengthen both sides. On the other hand, conflicts based on a win-or-lose orientation intensify the tension between opposing sides and make the wish to seek agreement look like weakness. Laboratory studies of human competitive behavior have shown that, contrary to the assumptions of many political leaders, greater capacity to threaten injury heightens competitive tensions. It also tends to reduce, rather than facilitate, the likelihood of reaching mutually satisfactory compromises.

Clearly, all nations stand to gain more by cooperation than by conflict. Coming to grips with the threat to human welfare from progressive pollution of the global environment, or the poverty and hunger of Third World nations, actually *requires* international cooperation. So, too, does tapping the potentials of outer space and the ocean depths. Work toward such superordinate goals will diminish tensions between adversaries and yield mutual benefits. This is not an idle dream. As proof, there is the success of the International Geophysical Year in the mid-1960s and the more recent Barcelona Conference on pollution in the Mediterranean Ocean, in which Israel and Arab nations worked smoothly in developing cooperative water-quality programs.

Some people will argue that seeking peaceful coexistence and nonviolent alternatives to war represents "starry-eyed idealism." But it is actually those who continue to think in terms of military triumph who reflect such an attitude. With the enormous destructive capacity that now exists on both sides of the East-West struggle, it is unrealistic to assume that either side can achieve traditional military victory. And it is irrational to assume that "our way of life" would be preserved for the tragic survivors of nuclear war.

Indeed, those who assume that we cannot survive in peaceful competition with Communist countries show a serious lack of faith in the strength and vitality of democratic society. There are huge sources of untapped productive strength in the West—from natural resources to human creativity—that, given a world at peace, have an enormous potential for continued development.

As the preamble to the Constitution of UNESCO says, "Wars begin in the minds of men." Since this is so, our minds must also be capable of ending war. □

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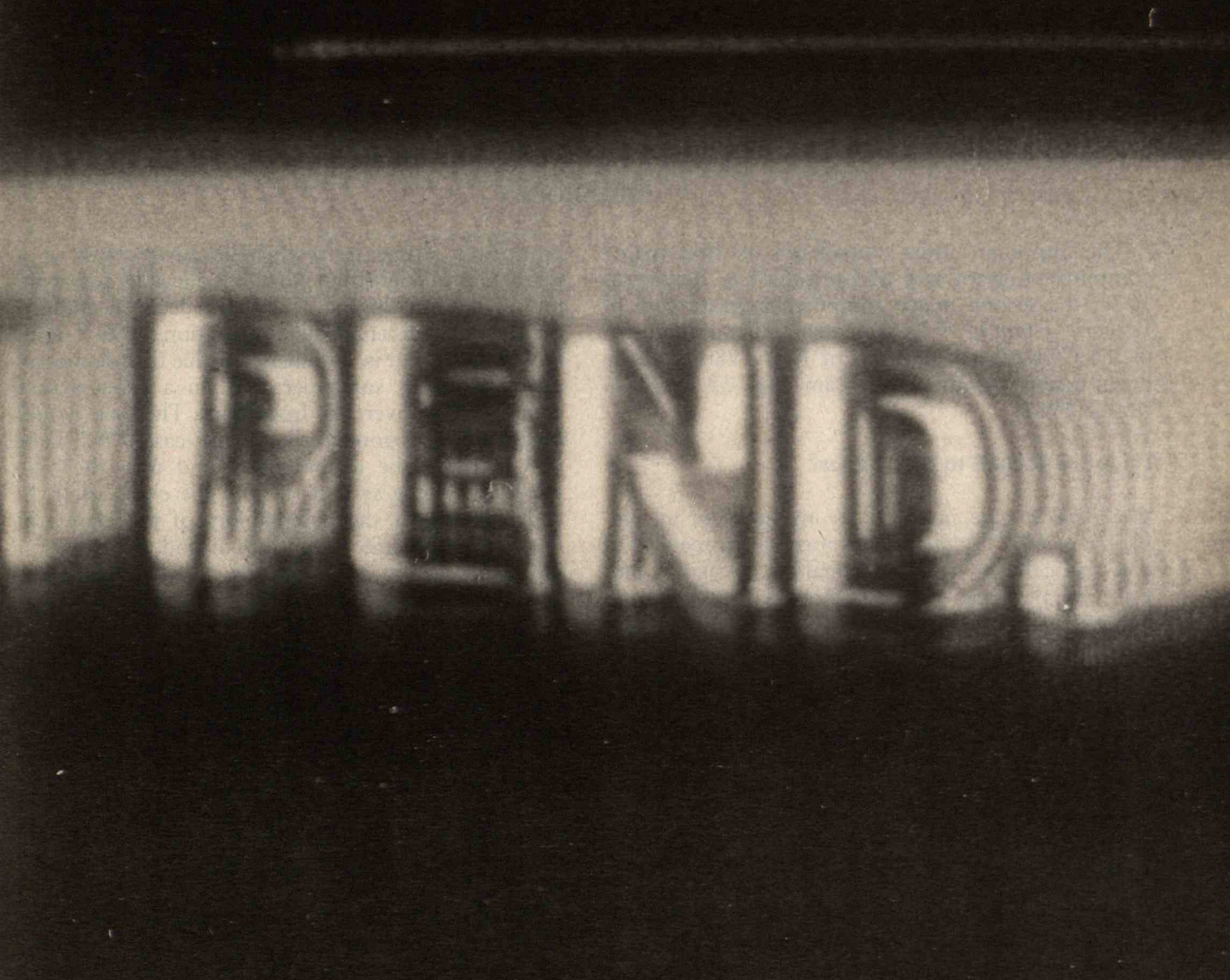
Lifeforms, Computer Programs, and the Pursuit of a Patent

BY DAVID A. BLUMENTHAL

Recent Supreme Court decisions may assure the leads of two American high-technology industries—software and genetic engineering—in world markets.

It used to be easy to define what was new and patentable and what wasn't. An inventor could reasonably expect a patent for almost any discovery. But with the growing sophistication of technology, definitions of newness have become blurred. Two areas in particular—computer programs and genetic engineering—have provoked long-standing controversies between the U.S. Patent and Trademark Office (PTO) and hopeful inventors. And both have been the subject of recent U.S. Supreme Court decisions.

In *Diamond v. Chakrabarty*, the Court decided that a human-made microorganism could be patented, and in *Diamond v. Diehr*, that a



computer-controlled process could be patented as well. Eye-catching headlines in major newspapers dramatized and exaggerated these two decisions, implying that the Supreme Court had OK'd patents across-the-board for lifeforms and computer programs. Now that the controversy has cooled, it is possible to assess the results rationally: to see what, specifically, the Supreme Court decided and what the implications might be.

The Supreme Court did not rule on the patentability of lifeforms and computer-related inventions (sometimes called "software" patents or computer-program patents) at the same time. The issues had a common underpinning, however, and the cases were deliberated closely enough together to have a notable impact on each other. Both revolved around a basic legal issue: did the subject matter properly fall within one of the categories of invention defined in Section 101 of the 1952 Patent Act? These categories were a carryover from earlier patent laws that evolved from a 1790 statute, "An Act to Promote the Progress of the Useful Arts." Subject-matter patentability is defined in Section 101 as follows: "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."

Two further requirements—novelty and non-obviousness—are distinct from the requirement of subject-matter patentability. They are designed to prevent the patenting of marginal improvements to the prior art. Even though a plan may pass the test of subject-matter patentability in Section 101, it may be rejected if it fails to meet the requirements of novelty and non-obviousness.

The legal question, simply stated, was whether computer programs or lifeforms fall within the scope of a "process, machine, manufacture, or composition of matter." The PTO said they did not; corporations, with an eye to their own or their employee-inventor's economic gain, said that they did.

ILLUSTRATION: TOM NORTON

Within the basic framework of free enterprise, the patent system has sometimes provided the only protection for the inventor.

The Supreme Court considered its first major computer-program case of *Gottschalk v. Benson* in 1972, the second major computer-program case of *Parker v. Flook* in 1978, the patentability of lifeforms in the *Chakrabarty* decision of June 1980, and the most recent computer-program case of *Diehr* in March 1981.

From the Mental to the Physical

The *Benson* case involved an invention of an employee of Bell Telephone Laboratories: a method of converting binary-coded decimal (BCD) signals into pure binary form. The method is applicable to telephone-switching technology, in which the BCD signals produced by a push-button phone are converted to pure binary form suitable for manipulation by computer. But although the invention had definite uses in telephone switching, the patent claims were much broader in scope and not restricted to a particular technological art. The Supreme Court was quite perturbed by the breadth of the claims, in fact, and held them unpatentable: "Here the 'process' claim is so abstract and sweeping as to cover both known and unknown uses of the BCD to pure-binary conversion. The end use may (1) vary from the operation of a train to verfication of drivers' licenses to researching the law books for precedents and (2) be performed through any existing machinery or future-devised machinery or without any apparatus."

The claim appeared to be nothing more than a "mathematical algorithm," which the Supreme Court defined as a "procedure for solving a given type of mathematical problem." Such a patent claim might, in theory, be infringed by merely *thinking*, a proposition that the Patent Office calls the "mental-step doctrine" and which it frequently uses to reject such claims—as it did in this case. Mental steps and mathematics do not fall within any of the categories defined by the patent act. The inventor and Bell Labs had argued that because a computer had to perform the mathematical steps—that is, the invention was "machine-limited"—the method was patentable. But the Supreme Court ruled that mere computer implementation of the mathematics was not sufficient. The *Benson* decision stood for the proposition that a patent claim may not preempt a formula: A mathematical algorithm cannot be claimed in the abstract.

The next important Supreme Court case involving computer software tested the protection of a mathematical algorithm when it is allegedly restricted to stated technologies. The *Flook* decision entailed the use of a mathematical computation for an "alarm limit value" (that is, a numerical value that defines an upper limit for safe operation) in a process that catalytically converts hydrocarbons. The issue would have been analogous to the *Benson* case if Bell Labs had included the technological end use—the telephone switching system—within the claim itself. In deciding against the patentability of the claims in *Flook*, the Supreme Court did not find the invention limited to the chemical conversion of hydrocarbons. The Court stated that "the patent application does not purport to . . . contain any disclosure relating to the chemical processes at work, the monitoring of process variables, or the means of setting off an alarm or adjusting an alarm system. All that it provides is a formula for computing an updated alarm limit."

The Supreme Court thus reasoned that the claim still appeared to be primarily a method of calculation. And although the claim was not totally preempting the mathematical algorithm, it was not physically restricted to any specific steps in the chemical conversion process.

The *Chakrabarty* case involved neither mathematical formulas nor computer programs, but a human-made bacterium for breaking down crude oil. Oil spills attacked by this microorganism are metabolically degraded into simpler substances. The PTO had already allowed claims for the *process* of producing the bacteria, and for an inoculum made up of a carrier material floating on water (such as straw) in combination with the new bacteria. The claims that the PTO rejected, which were then appealed to the Supreme Court, were for the bacteria themselves. The question was whether the Court would interpret the old statutory categories of patentability to include living matter.

The Court decided that the Section 101 language could indeed be given a broad construction, and thus it held the patent claim to be within the category of a "composition of matter." After reviewing the statute's legislative history, the Court concluded that Congress intended the subject matter within the categories of invention of Section 101 to "include anything under the sun that is made by man." The Court reasoned that Congress did not have to foresee a future technological development for something to be included within the meaning of the patent act. There-

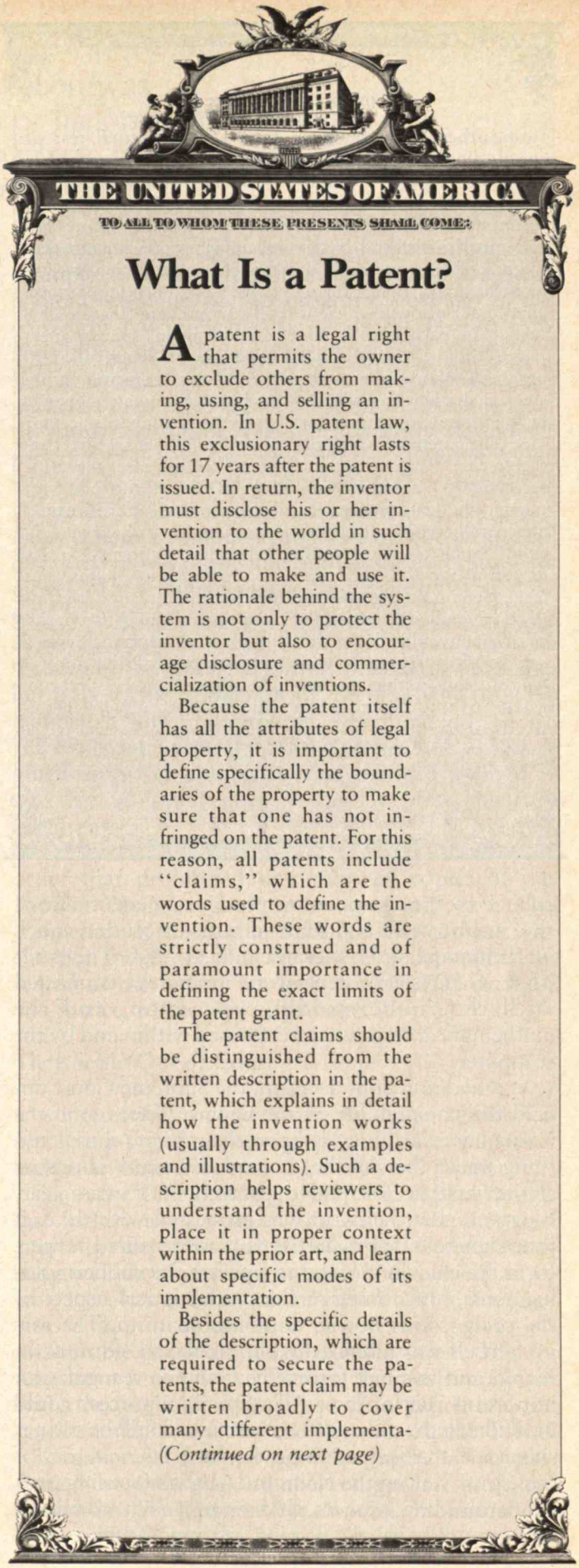
fore, the Court argued that it is wrong to assume that microorganisms are unpatentable unless Congress expressly denies their patentability.

Of course, the Court recognized that there are limits to this interpretation. Consistent with its prior *Benson* and *Flook* decisions, the Court reasoned: "A new material discovered in the earth or new plant found in the wild is not patentable subject matter. Likewise, Einstein could not patent his celebrated law $E = mc^2$ nor could Newton have patented the law of gravity. Such discoveries are manifestations of . . . nature, free to all men and reserved exclusively to none. Judged in this light, the respondent's microorganism plainly qualifies as patentable subject matter. His claim is not to a hitherto unknown phenomenon, but to a non-naturally occurring manufacture or composition of matter—a product of human ingenuity."

The Court's opinion strongly implies that all forms of life are proper subject matter for patent protection, as long as they are human-made and meet the other statutory requirements of novelty and non-obviousness necessary for all patentable inventions. "The relevant distinction," said the Court, "was not between living and inanimate things, but between products of nature, whether living or not, and human-made inventions. Here, the respondent's microorganism is the result of human ingenuity and research."

The *Chakrabarty* decision had a distinctly different philosophical tone from the *Benson* and *Flook* decisions, in which the court argued that since computer programs were not expressly considered by Congress, the patent laws should not be extended without specific authorization from Congress. The shift to a broader view of patent coverage may have resulted from persistent cries that U.S. technology is being hit hard by foreign competition, and as a counterreaction by the Court to its long-standing history of anti-patent decisions. But two simpler reasons also aided the change: Lifeforms are conceptually more concrete than the relatively ethereal computer programs, and the troublesome questions of "mental steps" that plagued the software cases did not arise in the lifeform cases.

With its attitude about the scope of patentable subject matter now expanded, the Supreme Court considered the *Diehr* case. The inventor wanted to patent a method of operating a rubbermolding press with the aid of a computer program. The press would be closed for exactly the optimal time, as repeatedly cal-



What Is a Patent?

A patent is a legal right that permits the owner to exclude others from making, using, and selling an invention. In U.S. patent law, this exclusionary right lasts for 17 years after the patent is issued. In return, the inventor must disclose his or her invention to the world in such detail that other people will be able to make and use it. The rationale behind the system is not only to protect the inventor but also to encourage disclosure and commercialization of inventions.

Because the patent itself has all the attributes of legal property, it is important to define specifically the boundaries of the property to make sure that one has not infringed on the patent. For this reason, all patents include "claims," which are the words used to define the invention. These words are strictly construed and of paramount importance in defining the exact limits of the patent grant.

The patent claims should be distinguished from the written description in the patent, which explains in detail how the invention works (usually through examples and illustrations). Such a description helps reviewers to understand the invention, place it in proper context within the prior art, and learn about specific modes of its implementation.

Besides the specific details of the description, which are required to secure the patents, the patent claim may be written broadly to cover many different implementa-

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tions other than the ones specifically set forth in the patent. For example, if the inventor were the first person to invent a chair, the descriptive portion of the patent might disclose one embodiment having a rigid, square-shaped surface with a leg attached to each corner. The patent might also disclose another embodiment with a single pedestal within the center of the square seating surface. The patent *claims* would then recite: "(1) a seating surface and (2) means for supporting the seating surface in a generally horizontal position." Such a claim would cover not only the four-legged embodiment and the pedestal embodiment of the chair but would also cover, say, a three-legged stool (since it falls within the language of the claim). The words of the claim, and not the description within the patent, are the actual test of what the patent covers.

Similarly, the words of the claim can restrict the invention to a specific feature. For example, a patent claim could recite a rocking chair as follows: "(1) a seating surface, (2) two arcuate [that is, curved] members spaced apart from one another, and (3) means for interconnecting each of the arcuate members with the seating surface for supporting the seating surface." In this case, the four-legged chair, the pedestal chair, and the three-legged stool would not be covered.

The patent attorney's job is to draft patent claims that neither unduly limit the invention nor make it so broad that it covers existing devices or abstract ideas. It is not unlike the task of the surveyor, who must accurately define the boundaries of real property.—*D.A.B.* □

culated by the computer, to produce a perfect cure of the rubber. The patent claims included both mathematical and nonmathematical steps. The latter (that is, physical) steps were intimately connected with the rubbermolding operation, and the mathematical steps were performed within and by the computer.

In a five-four split decision, the Supreme Court upheld the patentability of the claims. Once again the Court based its analysis upon the premise that "anything under the sun that is made by man" is proper subject matter for patent protection. It was clear, however, that the court was impressed with the fact that significant physical steps were required to perform the calculation and to operate the rubbermolding press, and therefore the mathematical aspect of the process was not its dominant feature. (The formula itself was admittedly old, unlike the formula in *Flook*, and this fact forced the Court to recognize an important rule of law: All steps in a process could individually be old and the claim could still be proper subject matter for patent protection.) The majority of the Court viewed the claim in *Diehr* as focusing on a rubbermolding process that employed a computer and a mathematical equation, as opposed to a computer executing a mathematical equation incidentally in the field of rubbermaking. The difference was important, since rubbermaking processes fell within the traditional category of a "process," whereas mathematical equations did not.

A Tool for Interpretation

Economic reward is the raison d'etre for corporate R&D, and patents provide an impetus for inventive efforts. Conversely, one may ask whether the patent system could be used to *inhibit* research in undesirable new technologies. Many who feared negative consequences of genetic engineering sought to apply the brakes of the patent system by urging the Supreme Court to refuse such patents. The Court declined, stating that its task was not to perform moral or social assessments. The Court said that it is up to Congress to make the required careful analyses and pass laws accordingly, for the role of the Supreme Court is only to interpret the laws in light of congressional intent. In considering the social risk that might result from upholding lifeform patents, for example, the Court stated:

"The grant or denial of patents on microorganisms is not likely to put an end to genetic research or to its attendant risks. The large amount of research that has already occurred, when no researcher had sure knowledge that patent protection would be available, suggests that legislative or judicial fiat as to patentability will not deter the scientific mind from probing into the unknown any more than Canute could command the tides. Whether the respondent's claims are patentable may determine whether research efforts are accelerated by the hope of reward or slowed by want of incentives, but that is all.

"What is more important is that we are without competence to entertain these arguments—either to brush them aside as fantasies generated by fear of the unknown, or to act on them. The choice we are urged to make is a matter of high policy for resolution within the legislative process after the kind of investigation, examination, and study that legislative bodies can provide and courts cannot."

If one fears that computers will adversely rule the world or that new lifeforms will produce a Frankenstein effect, the proper forum to express and debate such fears is Congress. As the Supreme Court recognized, prohibiting patents will not prohibit research and development. Thus, the blanket denial of patents

The legal question was whether computer programs or lifeforms fall within the scope of a "process, machine, manufacture, or composition of matter."

would be a logically ineffective and philosophically unfounded way to direct social behavior.

To Prevent False Expressions

Several legal alternatives to the patent system are currently in wide use by American industry to protect intellectual property. These alternatives include trade secrets, contracts, and copyrights.

In computer software and industry-sponsored genetic engineering, the trade secret is still the most popular form of protection. But it is not without its problems: keeping critical information secret is difficult and expensive. Employment agreements must be tough enough to be effective but not so restrictive as to be illegal and not so abrasive as to alienate employees. Under contract-law protection, a disclosure of the information is made to a licensee who is bound, under a carefully worded agreement, to use the information in a limited way while maintaining its secrecy. Of course, some products cannot be kept secret if they are to be sold on the open market. Confidentiality in computer games and home computer programs, for example, is simply not feasible. In such situations, software suppliers are turning to copyright protection.

In December 1980, an amendment to the new copyright act—only three years old at the time—made it explicitly applicable to all kinds of computer programs. Until then, the copyrighted work had to be embodied in humanly readable form. This old requirement dated from the 1908 Supreme Court case of *White-Smith v. Apollo*, in which the Court denied copyright protection for a piano roll because the code embodied in the physical perforations was not "writing" understandable by human beings and thus was not covered by the copyright act. As one can imagine, such a limited definition left no room for computer programs in their most useful, machine-readable form.

But with the expansion of the copyright law, the computer-software industry has been encouraged to use the copyright system for protection. Recent court cases, in fact, have confirmed the interpretation of the new law as applicable to code stored in read-only memories, and to popular video games in which a computer program controls the display. And because the registration procedure is simple and inexpensive, one can expect copyright protection to gain in popularity.

However, copyright law has its limitations. For example, even though protection is available against a literal copying of the program, nothing in the copyright law prevents the study of the program algorithm and the later independent development of a similar program. Indeed, because many different approaches may solve the same problem or implement the same algorithm, the independently developed program will generally produce the same net result and use the same input parameters as the copyrighted "original." For example, in a computer chess game many different computer programs may be written to direct the moves of the microprocessor in response to moves of the human player, and each of these programs may be separately copyrighted. Thus, copyright protection does not extend to protection of the idea or the general algorithm behind the program, but only to the *expression* of the idea—the detailed manner in which the program is written.

Even though protecting the expression of an idea is much narrower than protecting the idea itself, it is not without significance. A case in point involves video games. In a recent decision, the U.S. International Trade Commission (ITC) issued an exclusion order that prohibited unauthorized copies of the popular Pac-Man game from being imported. The competitor in this case had decided that copying was cheaper and faster. But the new U.S. copyright law served as the underlying basis for the ITC decision and justice, as they say, was done.

They Settle Out of Court

It is interesting to contrast the American system for protecting intellectual property with that of another highly developed technological society—Japan.

As in the United States, there is no explicit provision in Japanese patent law for either computer programs or lifeforms. But although the United States has a well-developed body of case law—which, as we have seen, has given its patent statute a wide interpretation that includes these new technologies—no comparable body of case law exists in Japan. This results from a number of factors, the most important being the nonlitigious Japanese social fabric and the explicit guidelines set by the Japanese Patent Office.

Litigation is frowned upon in Japan, a fact evidenced by the small number of general attorneys admitted to the Japanese Bar. Instead, discussion and compromise form the framework of the country's

The Court reasoned that Congress did not have to foresee a future technological development for it to be included within the meaning of the patent act.

legal system. For example, it is common in Japanese contracts to add a clause that calls for "consultation in good faith." Such a clause legally requires parties to iron out their differences without the aid of the courts. Only in recent years, as Japanese international commerce has grown tremendously, has litigation affected Japanese companies. In most cases, however, they have been the defendants, not the instigators of the suits.

As early as March 1976, the Japanese Patent Office created guidelines for computer-related inventions. These guidelines did not have the legal force of a court decision, but their actual effect may have been similar: patent attorneys typically advise their clients to follow them. What is remarkable is that these guidelines closely anticipated the present-day interpretation of the U.S. patent law. The Japanese guidelines state that a mathematical method of calculation is not patentable. But a computer-programmed invention that controls the operating of a rolling mill or a chemical process is definitely a proper candidate for patent protection. In Japan the claimed invention is patentable when the "causal relationship" underlying the process results from utilizing a law of nature.

The Japanese Patent Office has also established guidelines about lifeforms. In 1970 these guidelines held that microorganisms were unpatentable because they lacked industrial utility, as required under the Japanese Patent Law. But the office reversed itself in 1979 after realizing the importance of the patent system for the young bioengineering industry—in Japan and among its major industrial competitors.

The United States and Japan have thus adapted their patent system to encompass new technologies. And although their styles and origins differ, it appears that there is no substantial difference between U.S. patent law and Japanese patent practice.

Fewer Barriers, Greater Lead Times

Legal protection for creative effort is a cornerstone of business. The American Founding Fathers recognized the importance of patents and copyrights and provided authority for the patent and copyright system (in Article 1, Section 8, of the Constitution) to "promote the progress of science and useful arts." The patent system promotes industry in two ways. It gives the inventor legal rights to prevent others from making, using, and selling his or her invention, thus offering economic rewards to encourage invention and R&D investment. Patents also offer other inventors the benefit of published patent disclosures, which adds to the storehouse of knowledge and inspires further research and invention.

Within the basic framework of free enterprise, the patent system has sometimes provided the only protection for the inventor. For once a product comes on the free marketplace, competitors are quick to tear it apart and learn the "secrets" of its operation—a process termed "reverse engineering," which is both inexpensive and legal. Without the patent system, copying a product would also be legal.

It is already apparent that legal copying of American technology is widespread. At the same time, the quality and price of internationally competing goods have made it necessary for American entrepreneurs to try even harder to maintain a technological edge. Technological lead time—however short-lived—is provided by the patent system. Fortunately, the U.S. Supreme Court has sharpened the boundary between what is and what is not patentable in the areas of programmable inventions and microorganisms, thus improving patent protection in two high-technology fields in which the United States now leads the world.

The prospect of high rewards through adequate legal protection has been fundamental to the entire field of genetic engineering. Now that patents for lifeforms are possible, they will likely become the key form of legal protection for genetically engineered commercial products. But the effects of the Supreme Court's decisions on the software industry are less easy to predict. The long legal battles over computer programs, and the early setbacks from the Court's adverse decisions, forced the industry to rely heavily on trade secrets, licensing, and copyright protection. Patenting is now simply another viable alternative.

But how strong are the patents for programmable inventions and genetic engineering? Can these patents stand up in court and bring the anticipated economic rewards? The Supreme Court's decisions merely removed barriers; the legal strength and commercial success of any particular patent, as always, depend on the underlying invention and the resourcefulness of the entrepreneur.

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Genetic Engineering: To Patent Everything in Sight?

By Tamar Lewin

THE boom in biotechnology has not yet materialized. But a boom of another sort is well underway in biotechnology patents. And the manner in which patents are granted for biotechnology processes will do much to determine the shape of the industry that will turn these scientific advances into marketable products.

Although more than 100 new companies with names like Amgen and Genex have sprung up to explore the commercial possibilities of biotechnology—and most of the largest pharmaceutical and chemical companies are showing an interest, too—the only commercial product of gene-splicing to come to market so far has been a European vaccine against diarrhea in piglets.

Patents are regarded as the keys that will let the companies bring more products to the market. "This is a patent-intensive industry right now," said Thomas Kiley, vice-president for legal affairs at Genentech, the South San Francisco company that some analysts and scientists consider the leading new genetic-engineering enterprise. "A patent is an umbrella under which a small company can grow up."

Patents may also become bargaining chips that will allow small companies to function even if the giant pharmaceutical and chemical companies come to dominate the field.

Although they can offer no hard figures—because patent applications are confidential until granted—patent lawyers say that hundreds of biotechnology patents are now pending. Some claim protection for broad processes, which can be licensed out. Others seek to patent the end products they ultimately hope to market.

"When you have a chance to write on a clean slate, you can make some very basic patent claims, because the standard you're compared to is the state of the prior art, and there just isn't very much," said Mr. Kiley.

The first major domestic product of genetic engineering to reach the market is likely to be human insulin, which the Food and Drug Administration has approved. That should be followed by human growth hormone. In coming years, scientists and industry analysts expect the market to be flooded with everything from bioengineered microorganisms that can mine copper and gobble up oil spills to a specialized cancer therapy that will deliver treatment only to the cells affected.

For now, though, many of these new companies are primarily interested in gobbling up patents—and that depends in large part on a delicately poised agreement with Stanford University.

Closely Watched Patents

Until recently, it seemed likely that Stanford would dominate the field of genetic engineering because of the patent it won in December 1980, covering the basic method of gene-splicing known as recombinant DNA.

DNA, or deoxyribonucleic acid, is the combination of chemicals that determines inherited characteristics in all living organisms. In the patented recombinant-DNA process, which Stanford has licensed to 73 companies for $10,000 each, the genetic code from one organism is transferred to another, creating an entity with tailor-made characteristics.

Along with the process patent, Stanford and the University of California, which share the claims, are seeking another, closely related patent on a key product used in gene-splicing. The product patent—covering genetically engineered plasmids, the loops of DNA that scientists use to carry genetic material from one cell to another in the recombinant-DNA process—would be far easier to enforce than the process patent. By relying on the process patent, Stanford would have to go into laboratories and monitor ongoing work to determine whether unlicensed companies were using their patented method.

In a decision last August that shifted the balance of power in the gene-splicing world, the U.S. Patent and Trademark Office (PTO) issued a preliminary rejection of Stanford's application for the plasmid patent. In December, during the week when the PTO was expected to take final action, Stanford closed its files to the public. It will thus be unknown, at least for the several months required to issue a patent, whether or not the PTO reversed itself.

A rejection would imperil not only the plasmid patent but the earlier process patent as well. Scientists and lawyers agree that, because both patents are based on the same work by Stanley Cohen and Herbert Boyer, a final finding that the second claim was not patentable would likely provide grounds for overturning the original process patent.

"Any time there are two very closely related patents, action on one can affect the other," said Rene Tegtmeyer, the PTO's assistant commissioner for patents.

While the patent office listed a number of technical grounds for its preliminary rejection of Stanford's second claim, scientists say there are two main problems. One is the possible failure of the November 1974 patent application to describe the plasmid sufficiently to enable scientists to reproduce the invention. The other is an article published October 25, 1973, in *New Scientist* magazine, describing a paper Mr. Boyer had given at a scientific conference, known as the Gordon Conference on Nucleic Acids, earlier that year.

Under patent law, inventors have one year after the publication of their finding to apply for patent protection—and unfortunately for Stanford, the article appeared one year and one week before the patent application was filed.

The insufficiency and the earlier article were pointed out this summer by Albert Halluin, a lawyer at Exxon Research and Engineering Co., a company that—some say not coincidentally—did not get a license from Stanford.

"It was well known that [Mr. Boyer] had talked at the Gordon conference, but usually those speeches are not written up," said Mr. Kiley of Genentech. "I don't think anybody noticed the publication, or if they did, thought about its significance. It wasn't headlined 'There's big money ahead in this discovery.' At the time, it was just another scientific paper."

To win the patent, Stanford must now prove that the article did not describe the recombinant-DNA process thoroughly enough to allow scientists to duplicate the work—and that the patent application did.

Mr. Kiley and patent lawyers at other genetic-engineering companies will not venture an opinion on whether the article is so fully descriptive that it should block Stanford's claim. But they do agree that it is "highly pertinent."

Chips Off the Old Block

Stanford has a somewhat ambiguous relationship with many of the small venture-capital companies that have sprung up to explore the commercial possibilities of biotechnology. In some ways they work closely together, with Dr. Boyer sitting on Genentech's board of directors and Dr. Cohen acting as consultant to Cetus, the oldest of the biotech companies. Indeed, the presence of so many of the companies in Silicon Valley is directly attributable to the proximity of the Stanford and University of California scientific communities.

Still, as the companies begin to get their own patents on biotechnology processes and products—and especially as they begin to market products made with technology under license from Stanford—it would be in their interest to see Stanford's patents rejected.

There is a consensus in the legal and scientific communities that Stanford's patent claims are vulnerable to challenge, on the ground that they are too broad and not artfully drafted.

But there is also a consensus that the license was designed to be cheap enough to buy Stanford some time before the legal challenges begin. Licensees pay $10,000 a year until they begin to market products created with the Stanford technology, at which point they will also be charged royalties ranging from one-half of 1 percent to 10 percent of net sales. Even Stanford agrees that the patent will face legal challenges when there are enough products on the market to make the royalties worth fighting about.

Even then, it is unclear who would want the public image of suing to take away the profits of pioneering work by university scientists.

"Genentech can't sue Stanford," said one patent lawyer who works for a number of biotechnology companies. "They need a good relationship with the university. So they'll wait until someone else, probably one of the large chemical companies, does their dirty work for them."

Stanford, meanwhile, is at an impasse in its ability to sue those companies that are now infringing on its patent. Although the university was expected to begin going after some of the companies who use recombinant-DNA technology without paying the license fee, lawyers in the field say it would be sheer folly to do so until the patent office validates the university's claims. "Why should Stanford put the whole thing on the block unless someone challenges them?" said Leslie Misrock, a New York patent lawyer.

It is rumored throughout the biotechnology world that Mr. Misrock may be the one to file such a challenge. But Mr. Misrock says no such litigation is in the works—yet. "We have begun an inquiry on Stanford's patent claims," said Mr. Misrock, who has done biotech work for pharmaceutical companies such as Hoffman-LaRoche, and for smaller companies such as Agrigenetics of Denver, which recently won a broad process patent for using cloning techniques to produce hybrid seeds. "Our clients have asked us to look and see how strong the [patents] are. But we have not been asked to file any suit seeking to overturn them."

Jockeying for Position

It was not until the Supreme Court's 1980 ruling that living organisms could be patented that the PTO became active in what had long been an academic discipline thought to have no commercial use.

Indeed, while Stanford has a basic patent on the recombinant-DNA process, there is no analogous, broad patent for hybridomas, the products of two cells of different genetic types fused into one. For example, an antibody that recognizes a particular type of cancer cell could be linked to something that kills such cancer. The British scientists who did the key hybridoma work did not patent their work because they were told it had no commercial potential.

Such a lapse is not likely to recur, though. Because no one can yet predict precisely which process or microorganism will ultimately be of the most commercial importance, the most common impulse today is to get as many patents as possible.

"It's a revolutionary technology," said Zsolt Harsanyi, a vice-president of E. F. Hutton, who directed a two-year congressional study on the impact of genetic engineering. "The methods developed by the biotechnology industry are going to be of crucial importance to many other industries. What's happening now is that everyone is jockeying for position within the industry. As soon as it gets to the point where the products on the market make it worthwhile to sue, all the big patents are going to be challenged." □

TAMAR LEWIN, an attorney, is a reporter for the Business Day section of the *New York Times*.

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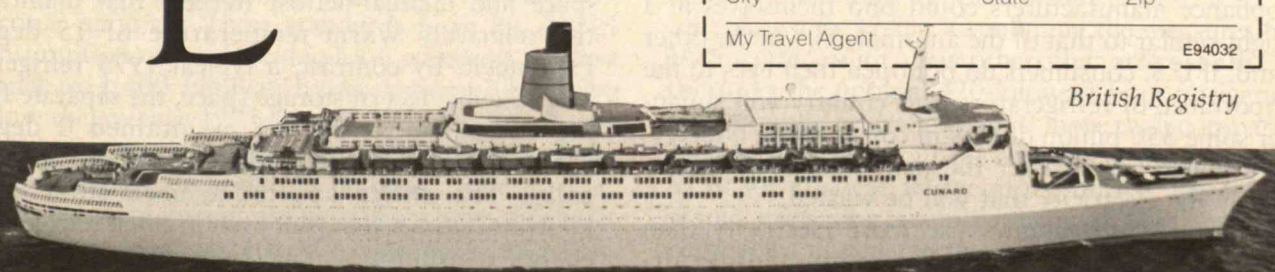


Refrigerator Reform: Guidelines For Energy Gluttons

BY DAVID B. GOLDSTEIN

Efficient appliances could save $200 billion in power-plant construction over the next 25 years. Unfortunately, the free market is not promoting such savings.

Refrigerators illustrate both the problem and the potential solutions.

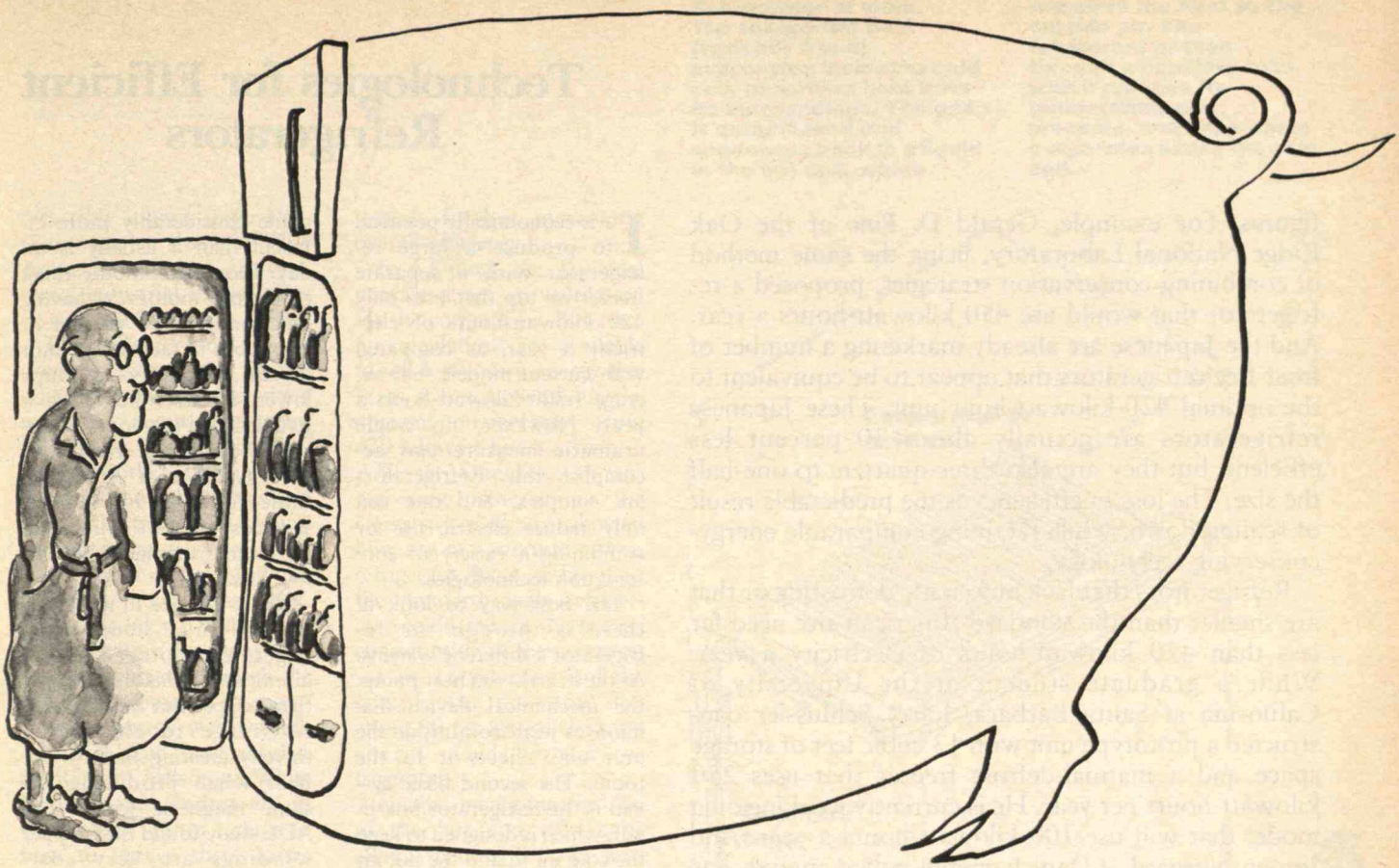
PEOPLE do not think of refrigerators as major energy consumers. Few weigh the $110 they spend on electricity each year to keep food cold in a typical frost-free refrigerator, much less the $2,200 they spend over its 20-year lifetime. Few consider the 17,000 megawatts of electric power—almost half the output of all nuclear plants operating in the United States in 1981—that is consumed by refrigerators alone. And doubtless few are aware that frost-free refrigerators now sold in Japan use less than half as much electricity as most comparable domestic models.

But refrigerators matter. Those Japanese models are not yet imported into this country, but if consumers should suddenly become concerned about the energy that efficient refrigerators can save, U.S. appliance manufacturers could find themselves in a plight similar to that of the automakers. On the other hand, if U.S. consumers do not open their eyes to the importance of refrigerators, this country will squander some $50 billion dollars in constructing unnecessary power plants over the next 20 years—just to supply the electricity that will be wasted.

Although refrigerators use more electricity than any other household appliance, including air-conditioners, they are only one appliance among many. Together, major electric appliances consume an average of more than 55,000 megawatts over the year, or some 24 percent of national electricity use. The United States faces a serious energy problem regarding these many unobtrusive home appliances, and so far, the free market has failed to produce a solution.

Cutting Energy Use by Two-Thirds

The electricity consumed by refrigerators grew by over 350 percent from the post-World War II period until 1975. Part of the increase was due to the fact that models were larger with more features. The earlier units, which consumed 350 kilowatt-hours of electricity a year, had about 7 cubic feet of storage space and manual-defrost freezers that maintained the relatively warm temperature of 15 degrees Fahrenheit. By contrast, a typical 1975 refrigerator had 15 cubic feet of storage space, the separate freezing compartment on top maintained 0 degrees Fahrenheit, and the unit defrosted itself automatically. The entire appliance used some 1,800 kilowatt-hours a year. But even in small refrigerators, energy consumption had risen from 350 to 600 kilowatt-hours a year—an increase of 70 percent. If



we count both large and small models, the average refrigerator sold in 1975 consumed 1,600 kilowatt hours a year.

Philco introduced a line of refrigerators that used 30 to 60 percent less electricity than comparable models in late 1974. These units were heavily advertised for their efficiency, but the line was hardly an overwhelming success. The manufacturer subsequently went out of the refrigerator business. Many other manufacturers, however, also introduced one or two models of comparably high efficiency.

In 1976 California began regulating refrigerator efficiency, and by 1981 manufacturers had complied with the California requirements in all 50 states. Models forbidden in California disappeared from national retail store catalogs; some manufacturers say the California standards have, for practical purposes, become national. These standards limit the energy consumption of a 15-cubic-foot automatic-defrost model to 1,400 kilowatt-hours a year—22 percent below the average 1975 level for that size. Since most models use less energy than the standard requires, the overall savings are about 35 percent.

But far more savings are possible: a large, frost-free refrigerator need use only 420 kilowatt-hours a year. This figure is based largely on two thorough studies performed by David Lee at Arthur D. Little, Inc. (ADL), in 1977 and 1980. Both proposed energy conservation measures for a typical large, frost-free refrigerator with the freezer on top. The added cost of each conservation measure would be paid back through energy savings within five years, and most measures would be paid back in one or two years. And none of the technologies is overly speculative: all could be mass-produced within six years.

The 1980 study proposed that various conservation measures, such as a more efficient self-defrosting system and double seals around the door opening, could produce a refrigerator using 650 kilowatt-hours a year. Although this study did not consider the motor and compressor—the mechanical heart of the refrigerator—the 1977 study did. It showed that making these more efficient would lead to a 29 percent electricity saving. Combining the measures from both studies, with a few others that are cost-effective, produces the optimal 420-kilowatt-hour refrigerator, which would cost about $150 more than comparable models sold today. If all consumers paid this extra $150 for efficient refrigerators, on the average they would each save an investment of $600 by power companies in generating capacity.

Other researchers have arrived at about the same

ILLUSTRATIONS: MICHAEL CRAWFORD

figures. For example, Gerald D. Pine at the Oak Ridge National Laboratory, using the same method of combining conservation strategies, proposed a refrigerator that would use 450 kilowatt-hours a year. And the Japanese are already marketing a number of frost-free refrigerators that appear to be equivalent to the optimal 420-kilowatt-hour unit. These Japanese refrigerators are actually about 30 percent less efficient, but they are also three-quarters to one-half the size. The loss in efficiency is the predictable result of scaling down, while retaining comparable energy-conserving technology.

Refrigerators that lack automatic defrosting or that are smaller than the standard American size need far less than 420 kilowatt-hours of electricity a year. While a graduate student at the University of California at Santa Barbara, Larry Schlussler constructed a prototype unit with 13 cubic feet of storage space and a manual-defrost freezer that uses 250 kilowatt-hours per year. He is currently working on a model that will use 100 kilowatt-hours a year. And Jørgen Nørgärd, a Danish energy-policy analyst, has described how to construct a small manual-defrost refrigerator with 4.5 square feet of storage for the European market that would use only 80 kilowatt-hours a year.

The best projections show that in 20 years, some 80 million new refrigerators will be in use in the United States. Reducing the average model's energy consumption from 1,300 kilowatt hours per year to about 400 (including large and small models) would save 10,000 megawatts of peak demand for electricity (or almost 11,000 including the electricity lost in transmission). Supplying this amount of electricity to consumers would require constructing 16,500 megawatts of generating power operating at the traditional 65 percent capacity. Building that generating power would cost $50 billion in 1981 dollars, and operating the plants would cost even more.

Where Is the Rational Consumer?

Even a decade ago the dimensions of this problem caused public concern. In 1975 the U.S. Department of Commerce proposed "voluntary" targets for improving appliance efficiency 30 percent; if manufacturers did not meet these targets, the government threatened to pass mandatory standards. In 1978 Congress decided standards were, in any event, necessary, and in the National Energy Conservation

Technologies for Efficient Refrigerators

It is economically practical to produce a large refrigerator with a separate freezer on top that uses only 420 kilowatt-hours of electricity a year, as compared with current models that average 1,300 kilowatt-hours a year. However, no single dramatic measure can accomplish this. Refrigerators are complex, and one can only reduce electric use by combining a variety of conservation technologies.

The best way to look at these is through the refrigerator's different systems. At the heart is the heat pump, the mechanical device that removes heat from inside the unit and rejects it to the room. The second basic system is the refrigerator box itself, which is designed to keep the cold air in and the hot air out. And third is the self-defrosting system—a big energy consumer on modern refrigerators. All three systems could stand considerable improvement.

First, the heat pump, which has a number of elements. The refrigerant fluid (typically freon) evaporates within the coiled network of pipes inside the refrigerator box known as the evaporator or cold coil—absorbing heat from the surroundings. The gas is then compressed by a pump driven by an electric motor. Under high pressure it condenses back to a liquid in the coiled piping of the condensor or hot coil. This hot coil transfers the refrigerant's heat to the surrounding air outside the refrigerator box. The liquid refrigerant then passes through a capillary tube (which reduces its temperature and pressure) and returns to the cold coil inside to evaporate once again.

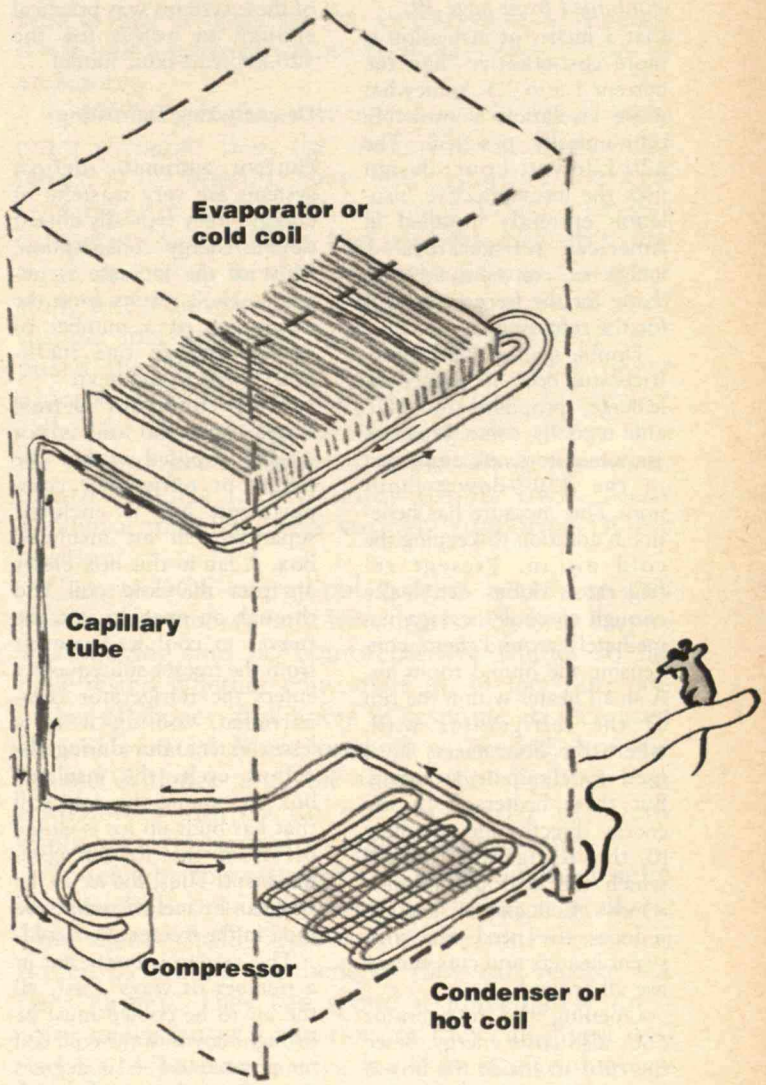
The electric motor that drives the heat pump can be made considerably more efficient than it usually is today. People commonly think of electric motors as having efficiencies of 90 percent or more, but in fact refrigerator motor efficiency is much lower. By the mid-1970s it had declined to about 70 percent; however, a study done by David Lee at Arthur D. Little (ADL) in 1977 found it very cost-effective to increase the motor's efficiency into the low 80s.

The wire used in the rotating coil in a standard refrigerator motor is often aluminum. This is cheaper than copper but has a higher resistance to electricity, thereby creating more waste heat when producing the same magnetic force. The ADL study found that copper windings are very cost-effective over the lifetime of the refrigerator.

Another cost-effective improvement to the motor proposed by the ADL study involves adding a capacitor, which stores electric current for brief periods of time. The problem is that in the coil the maximum current (analogous to the amount of water flowing through a pipe) is not synchronized with the maximum voltage (analogous to the water pressure). But the current and voltage work inefficiently when they are out of phase with each other. This allows large currents to surge back and forth through the coil, producing heat but no motion. By absorbing the current for a moment, the capacitor gets it in phase with the voltage.

The Japanese have used both these measures in their refrigerator motors and have also designed a third. The core—a solid piece of iron that intensifies the magnetic field produced by the coil—

Refrigerator at work. The refrigerant fluid (typically freon) evaporates inside the cold coil, absorbing heat from its surroundings. The gas is compressed and condenses back to a liquid in the hot coil, which transfers the heat to the outside air. The refrigerant passes through a capillary tube, which reduces its temperature and pressure, and once again evaporates inside the cold coil.



inevitably allows some electromagnetic losses. The Japanese employ conventional industrial technologies to engineer lower-loss cores.

The refrigerator motor drives a pump, and in the mid-1970s pump efficiencies were only about 50 percent. Friction in the pump's bearings and other moving parts was high, and the valves and ports admitting fluid in and out were poorly designed. This created unnecessary turbulence, wasting energy. Also, not all the fluid compressed within the pump was actually sent out through the valves, so some of the compression energy was wasted. The ADL study and another by Richard Nelson at White Consolidated Industries in Columbus, Ohio, showed how to reduce these losses significantly. Both studies predicted that improvements in compressors, including both the motor and the pump, would cut the refrigerator's overall electric use by 29 percent.

Improving motor and compressor efficiency reduces energy consumption not only directly but indirectly. Most motor/compressors are hermetically sealed units: in effect they are built within a bottle that contains refrigerant fluid. This leads to the refrigerator's traditional reliability. The refrigerant fluid serves as a coolant for the motor and prevents any overheating; also, the lubricant for the motor floats in the fluid. But the trouble is that the fluid absorbs all the waste heat that the motor and compressor generate. This heat has to be rejected in the hot coil, along with the heat from inside the refrigerator. Improving the motor/compressor therefore reduces the burden of waste heat to be rejected, further increasing overall efficiency.

In addition, the Japanese provide direct air ventilation for the compressor. But since no calculations are available to tell how much energy this saves, it is not counted in the optimal refrigerator using 420 kilowatt-hours a year.

W. F. Stoecker, an engineering professor at the University of Illinois, showed how use of a mixture of two refrigerant fluids, rather than the standard single refrigerant, could reduce the energy consumption of the compressor by 12 percent. And the compressor accounts for about 80 percent of the total energy used by the refrigerator.

Finally, increasing the size of the hot and cold coils allows them to transfer heat faster. Both ADL studies showed this measure to be cost-effective, and it is used in the 420-kilowatt-hour optimal design.

Plugging Leaks

The second subsystem, the refrigerator box, has already improved during the past 10 years as urethane foam insulation has replaced fiberglass. Indeed, this has been one of the major factors in improving efficiency. However, different types of urethane conduct heat at different rates, and the Japanese have recently introduced a new foam with a smaller and more uniform air-cell size that is a better insulator.

Other technologies may be able to reduce conduction even further. ADL considered the feasibility of constructing refrigerator walls with evacuated panels—in effect making the box into a thermos bottle. This proposal was rejected for the time being because it seemed too speculative, but it remains worthy of future consideration.

Increasing the thickness of the insulation obviously saves energy; however, choosing the optimal thickness is a complex matter. One trouble with increasing the insulation thickness is that it produces less storage space for given outside dimensions. And there are limits on outside dimensions—refrigerators have to fit through kitchen doors. Furthermore, different surfaces have different optimal insulations: the freezer compartment requires more than the refrigerator compartment. None of the studies has arrived at an optimal insulation thickness, though both ADL studies showed

(continued on next page)

DIAGRAM: JONATHAN SCHLEFER

(continued from page 39)
that 3 inches of insulation is more cost-effective than the current 1.5 to 2.5. Somewhat more insulation is probably economically practical. The 420-kilowatt-hour design uses the most effective insulation currently installed in American refrigerators—3 inches of conventional urethane for the freezer and 2.4 for the refrigerator.

Double seals around the refrigerator door to reduce air leakage, proposed by ADL and used by some Japanese manufacturers, are employed in the 420-kilowatt-hour unit. This measure has benefits in addition to keeping the cold air in. Present refrigerator doors are leaky enough to cool the area immediately around them, condensing the humid room air. A small heater within the rim of the refrigerator wall, where the door meets it, is used to eliminate sweating. But these heaters both use energy directly and add heat to the refrigerator box—which the heat pump must remove. Reducing air-leakage reduces the need for anti-sweat heaters and cuts energy use all around.

Opening the refrigerator door also costs energy. Since the cool air inside the box is heavier than the warm air outside, it tends to fall out. Ways to alleviate this problem have been suggested. For example, interior doors would greatly reduce the cold air the box loses, but they would also reduce the amount of food the refrigerator can store and would be inconvenient for the consumer. A horizontal refrigerator, with the door on the top, would also greatly reduce cold-air loss, but consumers might not find such a refrigerator acceptable. None of these systems was practical enough to adopt for the 420-kilowatt-hour model.

De-energizing Defrosting

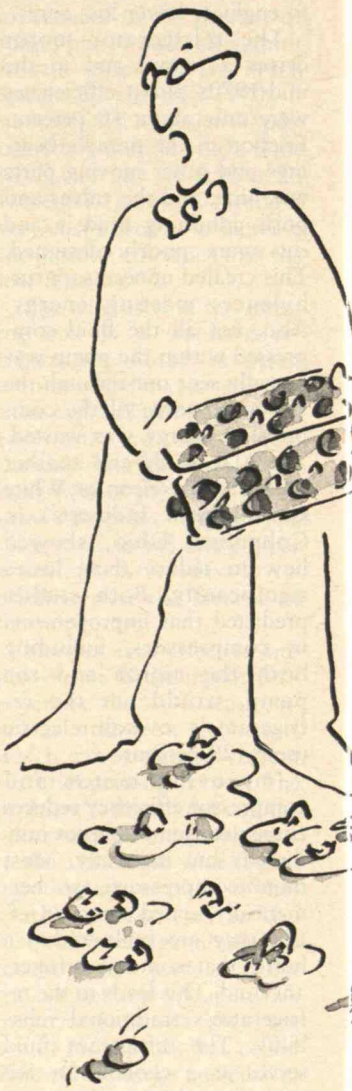
Current automatic defrost systems are very wasteful of energy—they typically almost double energy consumption. Most of the increase is unnecessary: it results from the interaction of a number of devices, where one inefficency feeds to the next.

In an automatic defrost system, the cold coil is not usually exposed within the freezer or refrigerator compartment, but is enclosed separately in an insulated box. A fan in this box blows air past the cold coil and through an opening into the freezer to cool it. Some air from the freezer subsequently enters the refrigerator compartment, cooling it to a lesser extent. But during the defrost cycle, the insulated box containing the cold coil that has built up ice is closed off from the freezer compartment. Thus, the ice in the box can be melted, while the food in the freezer stays cold.

This system is inefficient in a number of ways. First, all the air to be cooled must be brought down to the cold coil temperature of −10 degrees Fahrenheit. But the more a volume of air is cooled, the less humidity it can hold, so when the air passes by the cold coil it is dehumidified. This produces extra-low-humidity air for the refrigerator as well as the freezer. Squeezing humidity out of the air that will only end up in the relatively warm refrigerator compartment is wasteful. It takes a great deal of energy to dehumidify the air, and later it will take extra energy to remove the resultant frost from the coil. And this dehumidified air dries the food in the refrigerator, reducing the length of time it can be kept fresh.

The fan that blows air from the insulated box containing the cold coil into the food compartment uses energy and produces heat—which is blown into the freezer and must itself be compensated for by greater cooling. And the current of cold air blowing into the freezer and subsequently into the refrigerator means more leakage around the door seals, which in turn increases the need for anti-sweat heaters. The draft also means that more room air will enter the refrigerator and be dehumidified. The current system of defrosting involves an unfortunate feedback among a number of energy-consuming systems. The real wonder may be that, with such a design, contemporary refrigerators do not use more electricity.

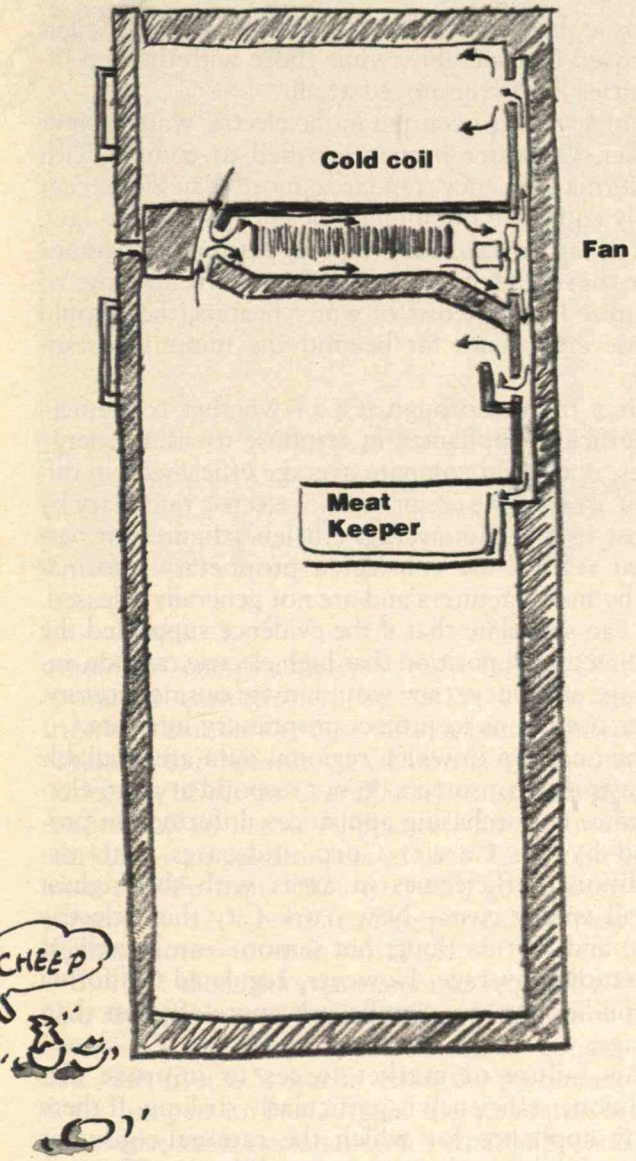
The most interesting proposal to reduce some of the waste in the automatic-defrosting system was made by the ADL study and is incorporated into some limited-production Amana models. In this system, there are two separate cold coils—one for the refrigerator and one for the freezer. The refrigerator-compartment cold coil collects some ice when it is chilling, but as soon as its running cycle stops, the ice evaporates since the compartment temperature is above freezing. The freezer-compartment cold coil can be much smaller than a standard cold coil. Also, it accumulates frost at a rate several times lower, so less energy is required for dehumidification, and the defrost cycles are less frequent and smaller. In addition, the smaller fan in the insulated box uses less electricity. The forced air current is required only in the freezer, so it results in less leakage past the door seal. In addition, both ADL and the Japanese moved the motor that drives this fan outside of the chilled box, so its waste heat is not carried into the freezer.



A few smaller improve-

ILLUSTRATION: MICHAEL CRAWFORD

An automatic defrost system. The cold coil is not exposed within the freezer or refrigerator, but is enclosed in an insulated box. A fan blows air past the coil to the food compartments. During the defrost cycle, the box is closed off, so the ice on the coil can be melted while the freezer stays cold.



ments can be made on the defrost system. The fan motor's efficiency can be improved, like that of the large compressor motor. Proper aerodynamic design can let the air flow past the cold coil at the most efficient rate. Instead of electric heat, gasses from the hot condenser coil can be used for defrosting. And the defrosting cycle can be initiated only when it is needed rather than at rigid intervals by a timer. But defrost-on-demand and the use of hot gasses from the condenser coil were considered economically marginal by ADL and are not incorporated into the 420-kilowatt-hour optimal design.—*D.B.G.* □

Policy Act, it directed the Department of Energy (DOE) to develop efficiency standards for 13 types of appliances.

In 1980 the DOE proposed standards significantly more stringent than the standards California had passed in the interim. These had required efficiencies comparable to the Philco and other energy-conserving models. They had not been difficult to enforce, according to the California Energy Commission, and manufacturers had not complained of trouble meeting them. But the manufacturers opposed the DOE standards, and they were never promulgated. Instead, in April 1982 the department called for eliminating standards, on the theory that the free market would bring about nearly equivalent improvements in efficiency on its own. Most appliance manufacturers strongly supported DOE's position.

Current DOE energy policy relies heavily on this free-market theory, yet it has surprisingly little empirical backing and no comprehensive studies so far have tested whether consumers do in fact purchase higher-efficiency appliances in response to increased electricity rates. More research is needed, but the limited evidence available shows the opposite: that consumers simply do not buy more efficient appliances in response to higher electric rates.

To see why this seems so, one must consider briefly the rational-consumer theory and what it predicts. This theory holds that consumers make rational trade-offs among the benefits they can receive for their money. They can spend it immediately on a color television or a vacation, or they can invest it—perhaps depositing it in a bank to receive interest. Paying extra for efficient appliances to save on future energy costs is a form of investment. When consumers do forego immediate spending, they expect their invested money to produce a return of more money—typically 1 to 5 percent more in real, or uninflated, dollars. Higher energy prices speed up the payback on energy conservation, and therefore should push consumers to choose more efficient appliances.

Supporters of the rational-consumer theory do admit that in some cases the market fails to work. For example, landlords and contractors who sell homes with appliances have little incentive to pay a premium for efficiency. Some consumers may be unable to afford an appliance of optimal efficiency. Other consumers may want to replace a broken appliance im-

DIAGRAM: JONATHAN SCHLEFER

Japanese refrigerators typically use half as much electricity as comparable domestic models. U.S. appliance manufacturers could find themselves in the automaker's plight.

mediately without studying efficiency. Still others may be ignorant about energy efficiency, or may not believe the efficiency figures they are given. But these market failures do not affect everyone, so the theory predicts that higher prices will generally lead to higher efficiency.

Was the free market responsible for recent improvements in refrigerator efficiency, or were the California standards responsible? To answer this question, consider the progress in refrigerator efficiency from 1975 (the first full year that an improved-efficiency model was sold) until 1981. Both types of large automatic-defrost units—with the freezer on the top of the refrigerator and the freezer on the side—increased dramatically in efficiency. But efficiency did not increase uniformly, as one would expect, in response to the generally uniform increases in electric rates. On the contrary, efficiency increased by discrete steps—related to the California standards.

Specifically, by 1981 the least-efficient two-thirds of the 1975 refrigerators had been dropped from production because they did not comply with the California standards then in effect. And most of the new, more efficient models were just slightly better than the standards required. But the high-efficiency 1975 refrigerators, already exceeding the California requirements, improved very little. Indeed, none of the 1981 side-by-side-freezer models and very few of the top freezer models were any more efficient than the best 1975 models.

This is completely inconsistent with the rational-consumer theory. If one accepts this free-market paradigm, then consumers should respond to higher prices in a way that increases the range of efficiencies available rather than decreasing it. Specifically, those who purchase their own appliances—and who make trade-offs between higher purchase prices and lower operating costs—should seek the most economically practical efficiencies. Given the relatively small $150 increase in refrigerator purchase price required to cut energy use by more than half, significant numbers of consumers should have desired such a model, and manufacturers should have met this demand. However, refrigerators purchased under market-failure conditions, such as those for rental units or vacation homes that may be occupied only a few weeks a year, should have shown little or no increase in efficiency.

Thus, the free-market theory predicts great improvement in the high-efficiency units and little improvement in the bottom of the line. But exactly the opposite happened: the bottom-of-the-line models improved considerably, while those with the best efficiencies hardly improved at all.

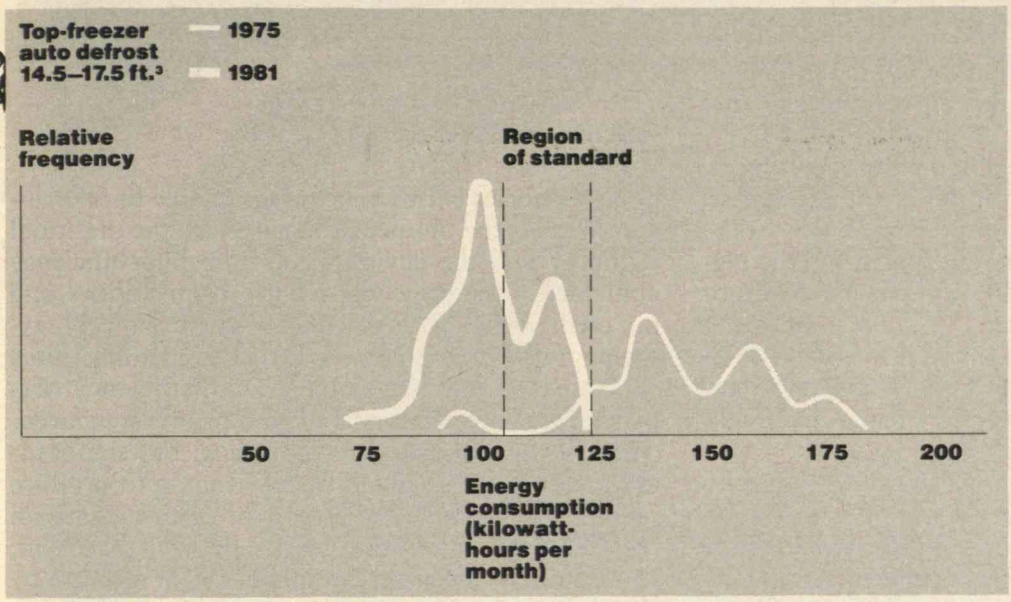
Similar results occurred in the electric water-heater market. Of water heaters certified to comply with California efficiency standards, more than 80 percent barely equal the minimum efficiency needed by law. This is again contrary to the rational-consumer hypothesis. If consumers were attempting to minimize lifetime costs of water heaters, they would choose efficiencies far beyond the minimum standard.

For a more thorough test of whether consumers buy efficient appliances in response to rising energy prices, one could compare average efficiencies in different areas of the country, since electric rates vary by almost 10 to 1. But average efficiency figures for particular regions are considered proprietary information by manufacturers and are not generally released. One can speculate that if the evidence supported the manufacturers' position that high electric rates do encourage efficiency, they would invite ouside scrutiny, under conditions to protect proprietary interests.

The one case in which regional data are available suggests that consumers do not respond at all to electric rates in purchasing appliances. Information provided by the Carrier Corp. indicates that air-conditioner efficiencies in areas with the highest overall energy costs—New York City (high electric rates) and Florida (long, hot season)—are merely at the national average. However, regulated California air conditioners *are* significantly more efficient than average.

This failure of market forces to improve air-conditioner efficiency is particularly striking. If there is any appliance for which the rational-consumer theory should work, it is air conditioners. They are widely perceived to use a lot of electricity, and efficiency data on them have been available for years. Furthermore, consumers have been able to purchase very high efficiency models at least since 1975. Yet air conditioners have had virtually the lowest improvement in efficiency of all appliances over the last six years—6 percent for central units and 18 percent for room models, despite the cost-effective potential of 100 percent.

Moreover, as in the case of refrigerators, efficiency improvements did not occur steadily, in response to the increase in electric rates, but rather in sudden steps geared to the California standards. These re-



Electric consumption of refrigerator models in 1975 and 1981. The least efficient were improved just enough to pass California standards, while the most efficient were improved little. This appears to be a direct response to the standards, not a result of free-market forces. (The 1981 data are available for California only, but no high-energy-consumption models are sold elsewhere.)

quired an energy-efficiency ratio (EER) of 7.5 for room air conditioners by 1979. Unlike the refrigerator standards, these did not become effectively national, but because of California's size, they did noticeably affect the overall market. According to the Association of Home Appliance Manufacturers, the market for air conditioners of over 7.5 EER increased most rapidly from 1978 to 1980, going from 29.6 percent to 42.5 percent. The percentage rose only slightly more—to 46.2—in 1981.

By 1981 the California standards required a higher EER, ranging from 8.2 to 8.7. From 1974 until 1980, between 10.7 and 11.6 percent of air conditioners had EERs over 8.5. But in 1981 the percentage suddenly jumped to 16.4. Again the standards are the most reasonable explanation for what happened. The responses to high prices would not occur in sudden jumps, since electricity costs nationwide have increased slowly and steadily since 1973.

Efficiency increases for central air conditioners also tend to have followed state standards. And although air-conditioner efficiencies as high as 14 are available and cost-effective, exceedingly few are sold. Manufacturers may beat the standard EER of 8.0 somewhat to allow a margin of error, but right through 1981, less than 5 percent of all air-conditioners sold had an EER of more than 9.5. Apparently, increases in electric rates have not encouraged many consumers to demand air conditioners that exceed minimum compliance with standards.

Why People Disobey Theory

Why do consumers fail to respond in significant numbers to high electricity prices? There are several possible reasons. Perhaps consumers are not aware that refrigerators are big energy users and that their efficiency is worth bothering about. If so, then publicizing refrigerator efficiency would be helpful.

Pacific Gas & Electric Co. in California launched a campaign to inform customers about appliance efficiency. PG&E did not merely publicize the importance of appliance efficiency and rank refrigerators by energy consumption. The utility also worked with dealers, and went so far as to offer retail salespeople bonuses for selling efficient appliances. But the program was largely ineffective.

A PG&E survey found that energy efficiency has very little impact on which appliance a consumer purchases. According to Owen Davis of PG&E, the study showed that energy efficiency ranks last among various features. Customers' concerns are first, price; second, features; third, brand; fourth, "suitability"; fifth, color; and finally energy efficiency. Most customers (68 percent) do not ask salespeople about efficiency, and most salespeople (70 percent) do not discuss it. Only 27 percent of all customers even believe there are big differences in energy efficiency among refrigerators. Several informal surveys of major appliance sales outlets by the Natural Resources Defense Council and the American Council

DIAGRAM: OMNIGRAPHICS

The fact that consumers fail to behave according to economic theory should not be a total surprise.

for an Energy Efficient Economy have confirmed that salespeople downplay appliance labels describing efficiency, claiming that they are inaccurate and that there are no real differences anyway.

The fact that consumers fail to behave according to economic theory should not be a total surprise. People make decisions in more complex ways than simply maximizing economic well-being. As the National Research Council stated, "The behavior of energy consumers is influenced by . . . the momentum of their past behavior . . . in addition to considerations of cost and expected return." Long neglect of energy efficiency is not likely to change overnight with higher energy prices.

The reason manufacturers do not respond to dramatic engineering advances is also clear: they are probably aware that consumers do not opt for high efficiencies in response to energy price increases. Improving efficiency requires investing in research and development, retooling production machinery, and changing marketing plans. Just the retooling and capital investments needed to make a relatively small change can cost about $20 million, according to Whirlpool Corp. Without evidence that such an investment will pay off in increased sales, a manufacturer would be imprudent to make it, beyond what is necessary to comply with standards.

However, manufacturers have vehemently opposed national standards to improve efficiency. In response to DOE's latest proposals, the Association of Home Appliance Manufacturers stated that the improvement record so far "shows that manufacturers are responding to free-market pressure to produce increasingly more efficient designs." Therefore, the association said, it "fully supports reliance on free-market forces [rather than standards] to accomplish energy conservation."

Manufacturers assert that consumers respond to high electric prices by buying cost-effective, efficient appliances. But if this is indeed true, then aren't the Japanese likely to take over a significant share of the home-appliance market, with their reasonably priced, efficient models? Or to meet this challenge, will U.S. manufacturers themselves double refrigerator efficiency in short order? But if so, why bother opposing standards that would require smaller improvements in efficiency? The U.S. manufacturers' position is seemingly inconsistent. The only plausible explanation for their failure to produce the high efficiencies that are technically practical is that they recognize, at least internally, that market forces are not demanding efficiency.

A Workable Policy

Several policies exist to encourage people to take advantage of the immense savings to the national economy and the environment from high-efficiency appliances. These include rebates from utilities and tax credits from governments for purchasing energy-saving units, government assistance to manufacturers for research and development on efficiency, expanded labeling and public education, and standards.

All of these options are promising, but standards are the only one that can be relied upon to produce predictable savings. The record of compliance with the California standards, for example, is excellent, and no direct consumer complaints were received by either the state or the manufacturers.

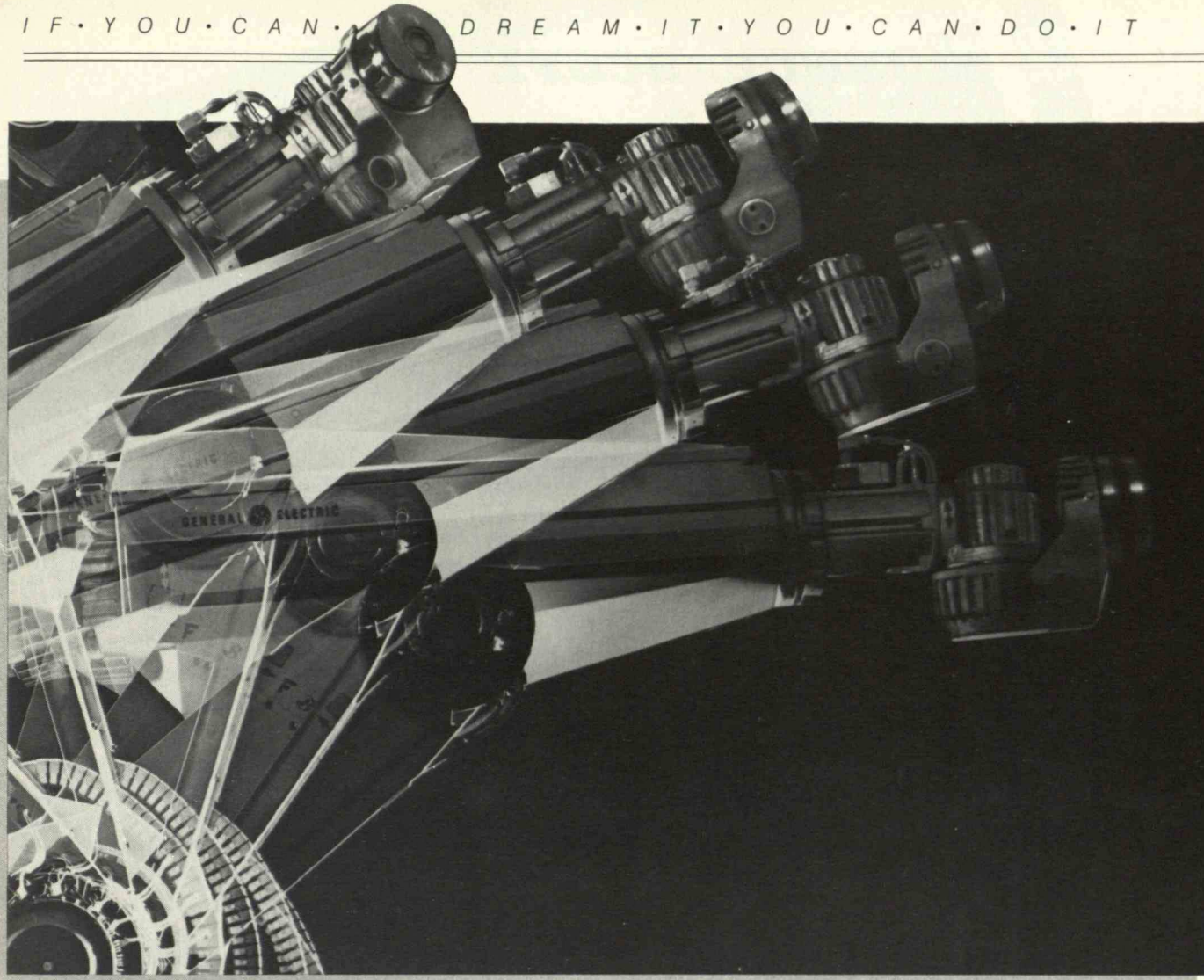
A subtle but important argument in favor of standards is that they are predictable. Utilities must plan up to 14 years ahead in constructing new base-load generating facilities. To do so, they must predict the energy consumption of home appliances, which account for a large portion of the load. With mandatory standards, future energy consumption is relatively easy to predict, but if the free market determines efficiency, there is tremendous uncertainty.

This is extremely costly to utility planners. It allows them three choices: they may make multi-billion-dollar investments that could prove to be unnecessary, they may risk shortages, or they may construct facilities on short lead times at higher costs. In supporting mandatory efficiency standards, several utilities have indicated to DOE that reliable forecasts are important.

Predicting the results of other policies is more difficult. In theory, rebates or tax credits for efficient appliances should work if consumers are demanding an unreasonably fast payback for efficiency, or if they have trouble paying for any increase in purchase cost. But if consumers are simply oblivious to energy considerations, then incentives may be ineffective.

The results of incentive programs are uncertain. A consortium of Texas utilities—Texas Power and Light, Texas Electric Service, and Dallas Power and Light—claims to be obtaining 50 percent participation in its air-conditioner rebate program. But a recent study of tax credits for weatherization by the

(continued on page 46)



Teach a robot the facts of life.

There was a time when most robots earned their livelihoods in comic books and science fiction films.

Today, they're spraying, welding, painting, and processing parts at manufacturing plants around the world.

Necessity has caused this amazing leap from fantasy to factory.

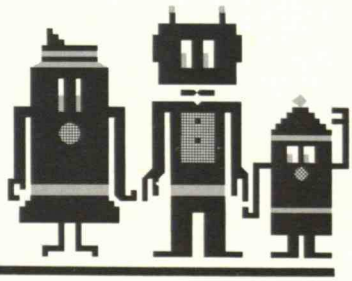
The world wants long-lasting, high quality products, now. And robots fit perfectly into this scheme of things: They can make those products – quickly, easily and accurately.

What kinds of robots? There is GE's Allegro,™ for one. It can position a part to within 1/1000th of an inch – or about ¼ the thickness of the paper this article is printed on. Or there's GP 132 (shown here). This loader, unloader, packer, stacker and welder – can lift and maneuver 132 pounds with no trouble at all.

So what's left for me to teach robots? You might ask. Consider this glimpse into the future by Dr. Roland W. Schmitt, head of GE corporate research and development:

"One of the big frontiers ahead of us is putting the robot's nervous system together with some senses – like vision, or touch, or the ability to sense heat or cold. That can give you an adaptive robot, one that can sense how well it's doing its job and make the adjustments needed to do that job better."

That's a tall order. And one we'll be expecting you to fill. With foresight, talent, imagination – all the things that robots have yet to learn.



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SCIENCE/SCOPE

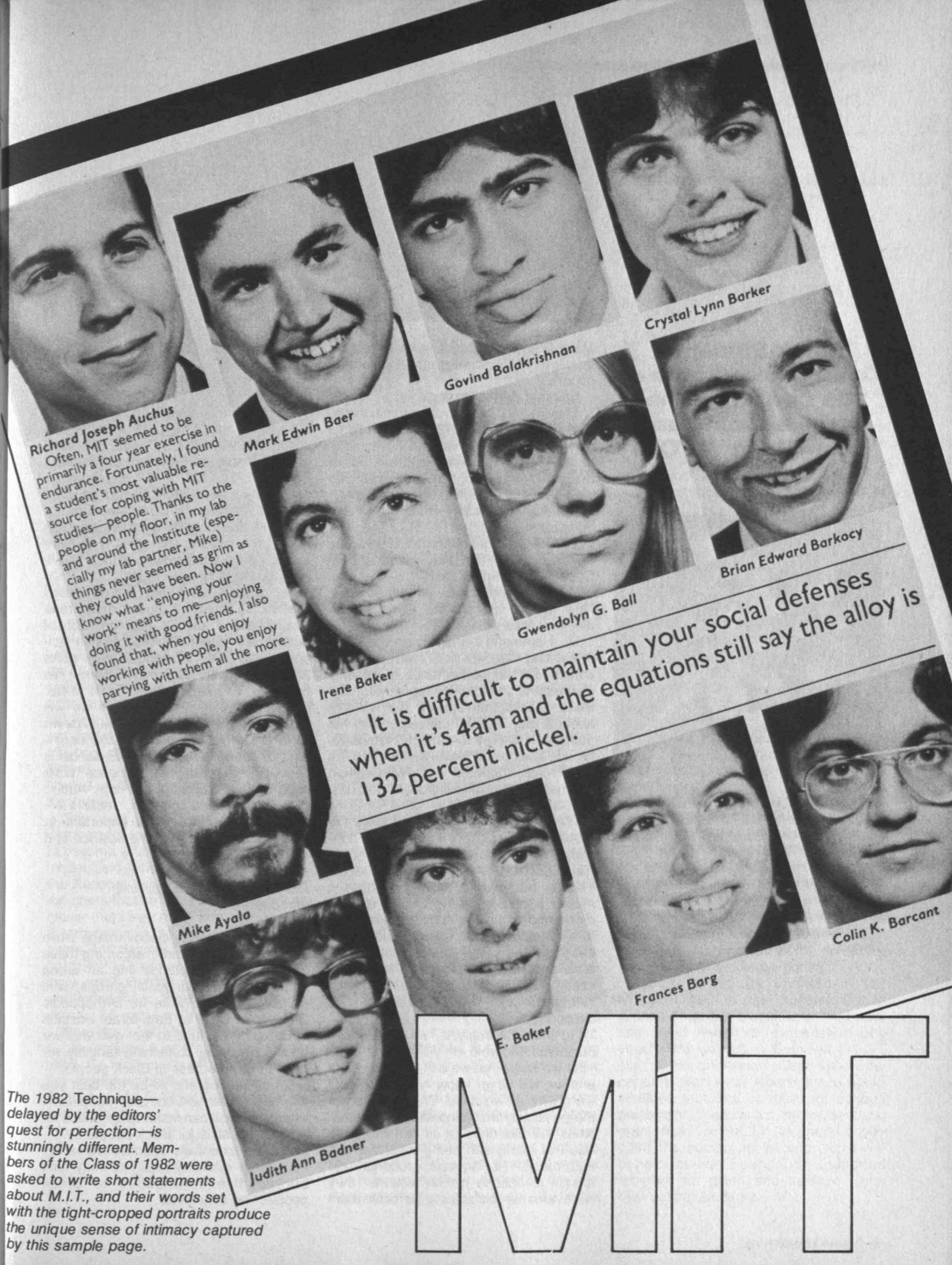
Two communications satellites made history as the first to be launched from NASA's space shuttle. The first of the pair, SBS-3, is operated by Satellite Business Systems and will carry high-speed data for many U.S. companies. The second, Anik-C, is operated by Telesat Canada and will improve telephone, television, and data service in Canada. The satellites are versions of Hughes Aircraft Company's HS 376, the world's most widely purchased communications satellite. Hughes now has built 70% of the world's operating commercial communications satellites and has more successes than all other companies combined.

A safety device that snuffs out explosions in the blink of an eye, originally developed for the military, is being applied commercially where fire poses an immediate threat to human life. The Dual Spectrum™ sensing and suppression system has been evaluated in New York Transit Authority toll booths. It detects fire bomb explosions set off by criminals, and suppresses them in one-tenth of a second -- before transit employees can be injured. The system could be applied almost anywhere fire explosions occur within an enclosed area. It was developed by the Santa Barbara Research Center, a Hughes subsidiary.

The Smithsonian Institution is installing a new security system to monitor many facilities continuously. The Hughes system includes burglar alarms, fire-sensing devices, voice communications channels, and closed-circuit TV. It will let Smithsonian personnel control entrances and exits, and watch over areas open to visitors. A computer will collect and display information on TV monitors and printers at a central control station. Hughes previously installed a facilities management system at the Smithsonian's National Air and Space Museum. That system provides a wide range of exhibit monitor and control functions.

The new thematic mapper aboard Landsat 4 has distinct advantages for mapping vegetation and land covers in comparison to the multispectral scanners used on previous Earth resources satellites. Improvements give the instrument better resolution (30 meters versus 80 meters) and enable it to see in narrower bandwidths. The green band measurers reflections from vegetation more precisely. The red band better distinguishes differences in the chlorophyll absorption of plants. The near-infrared spectral band reduces the chances of atmospheric vapor like fog and haze from obscuring land surfaces. Hughes and its Santa Barbara Research Center subsidiary built the thematic mapper from NASA.

Hughes needs graduates with degrees in EE, ME, physics, computer science, and math. To find out how you can become involved in any one of 1,500 high-technology projects ranging from subminiature microcircuits to advanced satellite technology, contact: College Relations Office, P.O. Box 1042 (C2/B178-SS), El Segundo, CA 90245. Equal opportunity employer.



The 1982 Technique—*delayed by the editors' quest for perfection—is stunningly different. Members of the Class of 1982 were asked to write short statements about M.I.T., and their words set with the tight-cropped portraits produce the unique sense of intimacy captured by this sample page.*

Black Students' Conference: "None of Us Can Avoid the Issue of Doing and Being What We Can and Must"

John B. Slaughter (above), then director of the National Science Foundation, was keynote speaker in the tenth annual Black Students' Conference on Science and Technology at M.I.T. The theme of the two-day conference: "the Black experience in science and technology: where we have come from, where we are, and where we are going." (Photos: James J. Snyder)

More Blacks than ever before are now enrolled in U.S. science and engineering courses.

How are they doing?

They're still in the role of minorities, said speakers at the 1982 Black Students Conference on Science and Technology at M.I.T. Their problem: to break out of that mold—"to integrate ourselves into the science and technology subculture," as Shirley A. Jackson, Ph.D.'73, of Bell Labs put it.

The idea of equal opportunity includes an assumption, Dr. Ray Hammond of Cape Cod Hospital said: ". . . that you and I, given the chance, would perform. Now, quietly, people are asking, How are minorities doing?'"

Dr. Hammond's answer: on the basis of existing data, there is cause for concern about the performance of minority students as a whole. He feels that many Blacks share that opinion but will talk about it only in quiet conversations, not publicly. It is easy to become defensive, he adds, recalling slavery, the effect on self-image, political betrayals, lynch victims. But that will not put off the question, he says.

"We can only approach and solve the problem if we confront it openly and honestly. We must *not* say we can't do some things because white people won't let us. This is our own form of bondage—it makes people band together in a common bond of sinking and despair. It fosters a mentality that shouts loudly 'let's eat drink and party—this academic stuff is no good anyway.' And that is a death knell for any possibility of a feeling of self-worth and self-actualization," he cautioned.

"In the final analysis, we have given ourselves the role of victim," he said. "But we know that we can be successful and we will never know how much until we give it all we have. We must accept the possibility that minorities may sometimes fail. But none of us can avoid the issue of doing and being what we can and must." He advised students and alumni to choose quickly whether they will overcome obstacles or perceive them as insurmountable mountains.

Know the System

"An important element of academic success is simply knowing the system—and many Blacks do not," said Cardinal Warde, Associate Professor of Electrical Engineering at M.I.T. "Whatever tactics are good for the nonminority are good for us too," he said. "If Black students are shy and don't chase a professor, they don't get questions answered. You have to find out how the system works, use it, and speak up for your rights."

Just as one must know the education system, so must the professional arena be understood, said Dr. Jackson. "Lots of politics are integral to success in science," she said. "We tend to work alone and develop an 'alone syndrome'. We have to avoid a 'wait for a date' complex—that if we work hard we will deserve and get recognition. We think we have to do Nobel work from the beginning or feel like a failure." Patience is needed, she cautioned—science work must be built one step at a time. Attend meetings, office parties, lectures—whatever will help. "It is important to make us more a part of the science and technology subculture.

Patience, Perseverance, and Perspective

Blacks have another disadvantage while pursuing a career and overcoming these obstacles to acceptance into an arena dominated by other racial groups, said Dr. Augustus A. White III, Orthopaedic Surgeon in Chief at Beth Israel Hospital in Boston: "We tend to feel guilt that we should be doing something tangibly related to the progress of Black people.

"I believe you should be the best you can be in what you do; then people will listen; then you can make suggestions for a better life style for Black people.

"To the extent we withdraw ourselves from other ethnic groups, we may limit our positive contribution to Black people," he concluded.

Students must be taught how to deal with failure as well as success; to move on to other arenas where they may excell. "We need patience and perseverance and a proper perspective of what failure is . . . The secret is to find *your* talent, find who you are and what your contribution can be," said Dr. Herman A. Young, a professor of interdisiplinary studies at the University of Louisville in Kentucky.

One way for a Black to encourage Black youth to enter technical careers is to become a university professor—a role model, said John B. Slaughter, director of the National Science Foundation. He remembers that he "was the first Black engineer that I ever met," he said. "There is a temptation to go into industry with a bachelor's degree; the number of Blacks holding Ph.D.'s in engineering is disturbingly small. But the rewards in teaching are important . . . You can give others a vision," he said.

More than 300 Black alumni and students registered for the two-day conference, the tenth in a continuing series and the first for which the organization Black Alumni of M.I.T. (BAMIT) took principal responsibility.

While he's helping minority students tackle the rigors of M.I.T., William McLaurin, director of the Office of Minority Education, has a larger vision: to make M.I.T. a vitally needed source of strength for science teaching throughout the U.S. (Photo: James J. Snyder)

Helping Minorities: A Special Case of A National Problem

"The quality of science education is a national problem—a national disgrace—affecting all students. And that makes it a double problem for minorities," says Dr. William McLaurin, who became the new Director of the Office of Minority Education (OME) at M.I.T. this fall.

"I'm not saying minorities are not prepared; I don't think the average student at M.I.T. is prepared the way she or he could and should be, irrespective of race or ethnicity," says Dr. McLaurin. "And without good preparation, M.I.T. is a hard taskmaster," he added.

Dr. McLaurin's primary goal in his new position is to ensure that minority students at M.I.T. do as well as they can do. OME offers tutoring, counseling, and a transitional program called Interphase, a seven week program of intensive preparatory classes for entering freshmen. Classes are held in chemistry, physics, mathematics, humanities and computer programming. A student-staffed tutorial program is offered four nights a week in which over 60 undergraduate subjects are covered. Throughout both semesters, an on-going seminar entitled "Strategies and Secrets of Academic Success" is conducted. During the Independent Activities Period in January, OME offers a number of seminars and courses. In addition, there is a "buddy system" that matches freshmen with upperclass buddies. One of the buddy's jobs is to ensure that his or her freshman buddy knows about Institute services and resources that may be needed. Dr. McLaurin's intention is to strengthen the existing programs and develop new ones.

Part of Dr. McLaurin's job is to ease the pressure on the minorities who come here. But he has a larger vision not unrelated to the academic support services provided by OME. The extent to which M.I.T. is successful in educating the students who come here is inexorably tied to the quality of science education in the public schools. He is fascinated by the question: What do you do to excite a student about science and math, and how can you maintain that level of excitement and concommitantly create a thirst for knowledge in youngsters? "One of the greatest barriers to education generally and science education in particular is the teacher, not the student," he says. While working in an Upward Bound program for high school students operated by Brandeis University, Dr. McLaurin was impressed by how much one could teach. "I was also negatively impressed by how *little* these students learned in the regular high school classes," added Dr. McLaurin. He, along with many others, has reached the conclusion that science education in the U.S. is a problem, and notes that as a nation, we fall far behind the U.S.S.R., China and Japan in science education. Dr. McLaurin believes that a leader must emerge if the problem is to be addressed effectively, and he views M.I.T. as the logical leader.

Dr. McLaurin draws from a number of experiences in his new position. He received his A.B. at Lycoming College, Williamsport, Pa., and holds the M.S. and Ph.D. in biology from New York University. He was a research fellow at Harvard Medical School, a Hamilton S. Burton Fellow with the Massachusetts Heart Association, and a postdoctoral fellow with the Medical Foundation in Boston. While he was with the Medical Foundation, Dr. McLaurin was involved in the screening and testing of sickle cell patients.

As an associate professor, Dr. McLaurin held a dual appointment in African-American Studies and Pharmacy and Allied Health at Northeastern University. He worked at Brandeis University, in the university's Center for Educational Services, where his responsibilities included counseling, college placement, financial aid, recruitment and grant development. Dr. McLaurin developed the curriculum for and ran a National Science Foundation-supported program for gifted and talented junior high school students.—*M.L.*

Chortling, smiling, raising beer mugs at an open bar at Delta Kappa Epsilon fraternity–the greeting to a curious press on November 22 to tell their story of the classic stunt at the Harvard-Yale football game in Harvard Stadium (Photo: Harvey Shew, '83)

Anatomy of a Hack: The Dekes Show How They Did It

When that black balloon emerged from the turf to startle packed stands at the Harvard-Yale football game on November 20 (*see* Technology Review, *January, page A10*), it was propelled by a device designed four years before to do just what it did. All that was left for today's members of Delta Kappa Epsilon fraternity was to perfect and install it.

The blueprint (*right*) shows how it worked: power from a 110-volt circuit used for the stadium's sprinkler system started a small motor which, through mechanical gears, released the pressure from the freon gas canister. That drove the shaft upward. When the device broke ground, marbles acting as ball-bearings allowed the aluminum cap and dirt above it to roll out of the way. Long chains at the bottom prevented the shaft from being pushed all the way out, and rachets then locked it into place. When the pull cable pulled at the contact points (from a 1967 Ford Mustang), current flowed up the wire to activate the large motor, which operated the air pump. (Large motor and air pump were part of a vacuum cleaner assembly.) This blew up the weather balloon, which eventually burst from its own pressure. The baby powder, which caused a cloud of dust when the balloon exploded, was packed in with the folded balloon so it wouldn't stick to itself and to act as a dessicant to absorb water.

Engineers of all types worked on the design. Tests were made, parts honed to perfection using the old trial-and-error method. "First we adapted materials, like the points from the Mustang; then we added pieces made especially—some of them machined to a fraction of an inch," explains Deke's President Bruce Sohn, '83.

The idea of embarrassing Harvard had been brought up at the Deke house every year when the classic football confrontation played at Harvard. The wound from the abortive effort of 1948 had never really healed. (In that year the Dekes had planted explosive cord under the stadium turf to raise the initials M.I.T. during the game, but the plan was discovered and both Harvard and M.I.T. took a stern view of the prank.) It wasn't unusual to find a group at the Deke house sitting around drinking beer and throwing around ideas.

"The actual *doing* of it was very exciting—like cops and robbers. We don't often get a chance to act out those kinds of fantasies," said Mr. Sohn, looking like the cat that just swallowed the canary.

Faces blackened with grease paint, clad in army camouflage fatigues, they waited in the car for a thumbs-up sign from a scout. Then it was park unobtrusively, stealthily make way a quarter mile to the stadium, climb a seven-foot wrought-iron fence to get in. Walk in the shadows, dive down flat when car headlights or the timed stadium searchlight illuminate the field. (Eight such expeditions between 1:00 a.m. and 5:00 a.m. were needed to safely install the machine.)

It went off perfectly. Deke fraternity members in the stands were ecstatic—as were the news media. Alumni were equally effusive, says Mr. Sohn: letters and phone calls were still coming in during December. The Disabled American Veterans sent a citation to the fraternity for boosting morale in a DAV hospital—they were watching the game when The Thing appeared.

"Gray to Bok:
Please Give It Back

What will become of it?

"Gray to Bok: Please give it back" screamed a headline in *The Tech*. Here is President Gray's letter to Harvard University President Derek Bok:

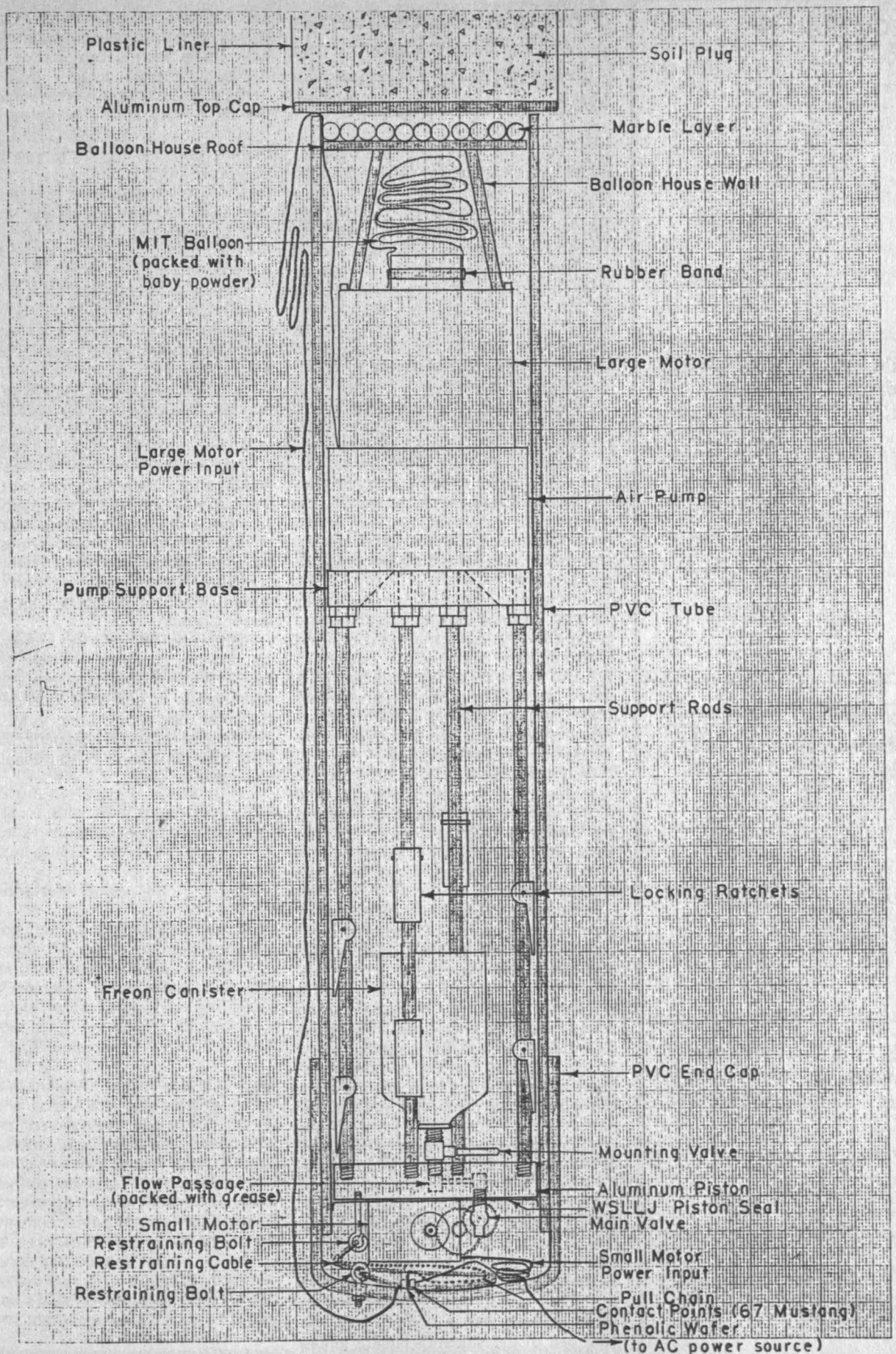
"Dear Derek, "Word has come to me that your campus police are holding some property which rightfully should be located in the M.I.T. Museum. Can this be true?

"Surely you have little use for a makeshift device constructed from vacuum cleaner parts, points from a 1967 Mustang, and a handful of marbles. We, however, being the sentimental sort, would take great care of—indeed, we would enshrine—this symbolic highlight of the 1982 football season.

"Please give it back.

Sincerely yours, Paul E. Gray."

Following their brilliant success at the Harvard-Yale game on November 20, members of Delta Kappa Epsilon pridefully released this drawing. The basic device was made four years ago in the Deke house and since then constantly perfected. It was designed to wait harmlessly in the Harvard turf for as much as six months, but "it was hard to motivate people that far in advance," says Bruce Sohn, '83, president of the house. So installation was completed only four days before the game. (For a description of how it worked, see the first column on this page.)


Plastic Liner
Soil Plug
Aluminum Top Cap
Marble Layer
Balloon House Roof
Balloon House Wall
MIT Balloon
(packed with
baby powder)
Rubber Band
Large Motor
Large Motor
Power Input
Air Pump
Pump Support Base
PVC Tube
Support Rods
Locking Ratchets
Freon Canister
PVC End Cap
Mounting Valve
Flow Passage
(packed with grease)
Aluminum Piston
WSLLJ Piston Seal
Main Valve
Small Motor
Restraining Bolt
Restraining Cable
Small Motor
Power Input
Restraining Bolt
Pull Chain
Contact Points (67 Mustang)
Phenolic Wafer
(to AC power source)

by Dick Deke

Personal Computers: Is There an Educational Impact Worth the Expense?

How may personal computers best become a part of education at a school like M.I.T.?

The Institute is wrestling with that thorny question—and opinions vary widely. Some think we should have had more machines—especially for use by students—five years ago and should now be matching the plans of several colleges, such as Carnegie-Mellon, to put a pesonal computer in the hands of each student. Others think a personal computer would be a waste of time and money—and perhaps a distraction from the process of acquiring basic knowledge.

Says Professor Fernando Corbato, Ph.D.'56, director of computing and telecommunication resources in the office of the provost: the advocates tend to assume a positive educational impact—"an act of faith that something good will indeed happen."

One reason why M.I.T. is not instantly jumping on the bandwagon is that there is already a rich and mature computing environment of sophisticated equipment used in research at the Institute. Thus most graduate students—and many undergraduates through UROP or thesis research—are involved with major computing environments already.

Registration in introductory M.I.T. computer courses is already about equal to the number of students that make up the freshman class. Professor Corbato says, "Almost every M.I.T. student learns how to work a computer—yet we don't tell them to."

Another concern is the high cost of providing a quantity of personal computers. There are roughly 10,000 undergraduates, graduate students, and faculty, explains Professor Corbato, and if we spend $2,000 per computer (which doesn't buy much, he adds) we invest $20 million—or ask our students to do so—in machines that will be obsolete in three or four years. Add to that the costs of management personnel and maintenance. If the Institute can't absorb the cost, computers would have to be added to the already high tuition. In summary, he says, "economics and rapidity of change are both part of the problem."

A third issue—the computer's potential role in education—looks to Professor Corbato like a trade-off. There are only so many hours of faculty interaction with a student in four years. Would hours spent working with a computer be the best use of the student's limited tenure here? "It is very hard to measure educational value," says Professor Corbato. "Most attempts to use computers in education have been feeble—it ends up with drill machines," he says.

Yet if one has faith in the proposition that by the year 2000 everyone will have computers, says Professor Corbato, then there *is* reason to start early. The goal, at least eventually, is for everyone to learn how to use a computer in a casual, unobtrusive way that adds value to their normal activities. "It is like learning to drive—one needs that skill to function in a modern world," he says.

Professor Corbato thinks that M.I.T.'s next thrust may begin with the School of Engineering adding a few hundred research-quality computers (costing $10,000 to $15,000 each) rather than flooding the campus with thousands of smaller models. The research-quality computers would be used for intense interaction in a limited number of courses.

The benefit of having all students and faculty share such resources would be that all could discuss individual problems with each other. A common computer environment in which everyone shares assures "a synergistic effect in which the computer system becomes part of the natural teaching dialogue," says Professor Corbato.

High school students are already anticipating the possible need for a computer. "We're beginning to get calls from prefreshmen to ask what kind of home computer they should bring to M.I.T. (to the tune of $3,000 to $6,000). We tell them they don't need to—but they can if they want to."—*M.L.*

Computers are a major factor in engineering education at M.I.T.—as typified by this Joint Computer Facility open 24 hours a day in Building 1. The "consultants"—themselves students—have the role of tutors, helping users and taking charge of maintenance after hours. This "consultant" is James Paradis, '84, an electrical engineering major. (Photo: Calvin Campbell)

Computers Are His Bag, but Who Needs Megabucks?
There is Something to be Said for Academia After All

The following recollections and reflections of the Class of 1982 are reprinted from Crosstalk, *the joint publication of the Student-Faculty Committee of Course VI (electrical engineering and computer science) and the student chapters of IEEE and ACM.*

by Richard M. Soley, '82

Looking back is all I seem to be doing nowadays. My undergraduate years are almost done: they flitted by in less time than I expected. "Four years!" I thought. Well, four years have come and gone, and I seem to be looking forward to at least four more years under the "acid rain."

We all make fun of the "acid rain"—the Institute screw, the silly campus newspapers, the overwork, and so on—but we stay. Sure, some of us stay because of the money we might make later; some of us just like learning. It's not all that bad here, although that's in retrospect. I seem to remember some times when I wouln't have said that, particularly some mornings at 5:00 a.m.

I remember as a freshman trying to choose a major—silly me. I thought I was a born mathematician. When I finally realized that computers were my bag, I was scared by the sheer size and weight of Course VI. Too many people, not enough involvement. It took a lot to get over that feeling and do what I wanted to do. It didn't take me long to find out that electronics hated me (yeah, that's the way I meant to write it) and that software didn't—I was all set.

I think one of the major academically pleasurable things that happened to me here was the incredible openness of research. This I found not only in my own field but everywhere, in every field. I've said it before, thousands of times, and I'll say it again—find a UROP position, some independent research, something that interests you. There's nothing like the feeling of doing real, hands-on, useful work at a laboratory on campus. The Laboratory for Computer Science was my find, but there are dozens of others.

Three and a half years, and then—*wham*!—the big decision. Industry and megabucks, or academia and more time for thought and discovery? Like many of my friends, I chose to continue my education, and applied here, in good ol' Course VI, and (in the words of Professor Moses) "They let you in?" Well, they did. That's their problem. I'm not unhappy—I've got graduation to look forward to, and a new experience in the fall—who needs megabucks? There is something to be said about academia, after all. Heck, you get summers off.

Under the Domes

A $175 Million List of Things We Need

The list of urgent Institute needs given to Professor Samuel A. Goldblith, '40, vice-president for resource development, by President Paul E. Gray, '54, and his faculty at the end of 1982 contains at least $175 million of new endowment and plant.

Near the top of the list, as presented to members of the Corporation Development Committee on November 19:

☐ $1 to $5 million more each year in unrestricted income, to eliminate a recurring deficit problem. (M.I.T. expenses may overrun income by as much as $2.7 million in 1982-83, William R. Dickson, '56, senior vice-president, had told the CDC.)

☐ At least $5 million for undergraduate scholarships and graduate fellowships to offset losses of federal programs.

☐ At least $20 million in new endowment for professorships and career development professorships; there are now only 120 endowed chairs for a faculty of 1,200.

☐ Between $2 and $4 million for renovating undergraduate chemistry laboratories. Unchanged since 1916, they're now in "really dreadful shape," Professor Goldblith said.

☐ New facilities for engineering design, physics, brain and cognitive sciences, and VLSI (very large integrated circuit) teaching and research.

Why so many needs when the most successful capital campaign in the Institute's history ended less than three years ago? asked a CDC member. These are new needs, dictated by changes unforeseen when the Leadership Campaign was charted a decade ago, said Dr. Gray. It's characteristic of both education and technology, he said, that "the farther you go the behinder you get."

Nor could the political changes of the 1980s have been foreseen—the decrease in real terms in federal support for basic research, the inroads into student aid programs, the reduced overhead allowances of many grantors. Reduced federal support hightens the competition for research funds, and this in turn preoccupies faculty and so puts pressure on the process of curricular innovation and improved teaching, said Dr. Gray. Thus there is, he said, "pressing need for resources at the margin."

The task, in Dr. Gray's words: "To preserve the possibility for innovation in the synergism between 1,200 faculty with few peers and 9,000 of the most exciting young people in the country."

Dean Gerald L. Wilson, '61, of the School of Engineering responded with confidence. No school at M.I.T. is harder pressed financially, with unprecedented increases in enrollment. The entire school—and within the school every department—is now in the midst of a long-range planning effort to identify new initiatives and the older activities they should replace. The challenge of the difficult external environment is seen as an opportunity, said Dean Wilson: "We are going to do it, so help me!" he pledged.

A Center to Study the New Power of Sensory Images

Gifts and pledges of $19.7 million have now been assembled for the new arts and media technology center under construction on the East Campus. Total cost of the building will be $26 million, and raising the $6.3 million still needed is the highest priority of the Council for the Arts at M.I.T.

The building is being built much as it's being funded—progressively, said I.M. Pei, '40, its architect, reporting at the council's annual meeting on November 12 in Cambridge. The foundation was finished before final drawings for the superstructure were ready, and now that the superstructure is being built (bids were 11 percent below estimates) final interior details are being developed. But despite this somewhat *ad hoc* process, Mr. Pei was confident: "I look forward to greeting all of you at the opening in the fall of 1984," he told members of the council.

What will the members find when they claim their new building in two years? No one can be quite sure.

President-Emeritus Jerome B. Wiesner, chairman of the council, said he was astonished at how the process of planning the building had brought together the arts and related technologies with new strength and excitement. Boundaries are disappearing, he said, and plans are changing. What will go on in the new workshops and studios can only be guessed.

Dean John de Monchaux of the School of Architecture and Planning has an ambitious vision. The building will mark the start of a new field at M.I.T.—"understanding the making and the meaning of sensory images." Sensory images contain vast amounts of information. New ways of generating, transmitting, and storing them will give this new realm importance that "cannot yet be fully recognized," he said. What will be learned will have "extraordinary impact in communications, in designing, in the making of art, in how humans interact with machines, and in learning."

Three major announcements during the Council on the Arts' annual meeting:

☐ An endowed fellowship fund, providing an annual award to a graduate or post-graduate student in the arts, was given to M.I.T. by Angus N. MacDonald, '46, with participation by Margaret McDermott and Institute Professor Walter A. Rosenblith. It is named in honor of Institute Professor Emeritus Gyorgy Kepes, whom Dr. Wiesner described as "the beacon that guided us" in developing the activities supported by the council.

☐ The McDermott Award for support of the arts at M.I.T. was made at a private dinner of the council to Professor Emeritus Roy Lamson, who retired last June as the council secretary.

☐ The Kresge Foundation will add $1 million to the funds for the building if the funding can be completed by December 1983. President Paul E. Gray, '54, said the challenge grant will have a "powerful impact" on fund-raising.

On October 7, 1982, a full house of M.I.T. students, faculty, and staff gathered to honor Majorie Pierce, '22, by naming the Women's Independent Living Group (WILG) residence after her. Above, from left, are Laurel Carney, president of WILG, President Paul E. Gray, and Marjorie Pierce. (Photo: Calvin Campbell)

Marjorie Pierce, '22, Shares Her Name

"By naming our residence the Marjorie Pierce House, we're taking on roots," said Beth Tavrow, '79, president of the Women's Independent Living Group (WILG) alumnae corporation, at the dedication ceremony early last October.

And these are *some* roots. "Imagine, 81 years old and still going for it," is the way a 12-year-old Weston, Mass. neighbor describes Miss Pierce, who is still a full-time architect. The secret of her vigor? "Good genes. A tremendous health record. And I think I've found my niche," she replies.

Marjorie Pierce graduated from M.I.T. at a time when tuition was $300 a year, bread was five cents a loaf, and women graduates were very rare. She supported her education in a variety of ways—dining hall jobs, selling fudge in the labs, and ushering at the Exeter Street Theatre. Films were silent, so she was able to stand under the EXIT light and study. She went through her undergraduate work without a scholarship to prove a woman could do it, but later got one for graduate work.

After graduation Miss Pierce won a trip abroad and was later awarded the James Templeton Kelley fellowship by the Boston Society of Architecture, enabling her to study manor houses in England and France.

During World War II, architecture dried up, but she was able to find a job with Charles T. Main, Inc. as head of the drafting department for women. Under her leadership, the department grew from one to 47 women, many of whom were M.I.T. graduates. The group did 1,000 drawings of how to store 1,000 kinds of ammunition, but not one single drawing was ever used.

After the war she set up her own office, and estimates she has done 1,300 projects, ranging from New England to Virginia and from Ohio to Calgary, Alberta. She tends toward conservative architecture and best likes designing and remodeling. One of the hardest parts about architecture, she claims, is selling yourself. Clients usually do not know what they want, and you must help them discover what they want and need. It's very important to involve them in the process, she says.

Her ingredients for success? One must have drive (the desire to get ahead), must be in the right place at the right time, and must possess talent (a little bit).

Why did WILG choose Marjorie Pierce for their namesake? In addition to being very active in alumni affairs, Miss Pierce has worked closely with WILG and given her support in many ways, including developing and remodeling the residence to the stage it's at now.

Accepting the honor for all the others who've supported WILG, as well as herself, Miss Pierce said, "I hope that my name on this residence will represent to the members of the Women's Independent Living Group, past, present, and future, an alumna who, with a minimum of talent, a lot of hard work, and a lifelong dedication to the Institute, was so honored."—*S.K.*

The Absent Bigger Bowl

A cup of soup costs 10 to 25 cents less than a bowl of soup in the Lobdell dining room. But according to research by Mark Plotnick, a graduate student in electrical engineering, and some of his friends as reported by Mr. Plotnick to *The Tech*, cup and bowl contain the same amount of soup.

Queried about this anomaly, a Dining Service employee in Lobdell told Mr. Plotnick that—yes, that's right. Lobdell's prices are based on eight-ounce soup bowls, of which they have none. But since "less than 10 percent of the people who buy soup know about that," there really is no problem.

The 1982 Bronze Beaver, the highest Alumni Association award for service to M.I.T., was given to Guy J. Viellet, S.M.'50 by Denman K. McNear '48 (right), Association president. Mr. Viellet was cited as " 'Mr. M.I.T. of France' . . . instrumental in building the M.I.T. Club of Paris into our most active international club (and) . . . in introducing large numbers of companies throughout Europe to the Industrial Liaison Program."

Journalists' Fellowships

A new fellowship program to bring science and technology journalists to M.I.T. for a year's study of new developments in science, engineering, and public policy will begin next fall.

Named in honor of Vannevar Bush, '16, the fellowship program is funded by grants of the Andrew W. Mellon Foundation ($500,000) and the Alfred P. Sloan Foundation ($250,000, with additional funding likely). It will be directed by Victor K. McElheny, who has joined the M.I.T. Program in Science, Technology, and Society as a principal research associate.

Up to eight Bush Fellowships will be offered annually starting next fall. They'll be open to writers and broadcasters, including engineers and scientists, whose primary work is informing the public about recent developments in technology and science and their broader social impact.

The fellows will participate in a seminar within the STS program, and they will also visit laboratories and audit courses throughout the Institute. The idea, said President Paul E. Gray, '54, is to foster "a richer partnership between the technical and journalistic communities," with the goal of "continued public awareness about technology, science, and their growing influence on our lives and aspirations."

Mr. McElheny has served as a science and technology reporter with the *Charlotte* (N.Car.) *Observer, Science* magazine, the *Boston Globe,* and the *New York Times*. Before coming to M.I.T. he was for four years the founding director of the Banbury Center of Cold Spring Harbor Laboratory. He was a Nieman Fellow at Harvard in 1962-63 and a regular columnist for *Technology Review* during his tenure as science editor of the *Boston Globe* from 1967 to 1973.

Life Members Become Emeriti

Three alumni, previously life members of the M.I.T. Corporation, were honored last fall by Howard W. Johnson, chairman, as they became life members emeriti:

☐ **Kenneth J. Germeshausen,** '31, though only recently a member of the Corporation, was cited as "an adviser to five M.I.T. presidents" whose name has now been given to a building and a professorship at the Institute.

☐ **Gregory Smith,** '30, a Corporation member since 1967, has for the past decade given "more than 200 man-days of work a year" to the Institute through the UROP Program and "has served on more visiting committees simultaneously than anyone else in history," said Mr. Johson.

☐ **John J. Wilson,** '29, became secretary of the Corporation in 1959 and for the next 20 years signed every M.I.T. diploma, respresenting "fully half of all the degrees awarded by the Institute by the time he retired in 1979," said Mr. Johnson. He's also founded several successful companies and made five trans-Atlantic crossings under sail—"done it all," said Mr. Johnson.

Renewing the Search for Life in Space

Four M.I.T. faculty members joined a national appeal late last year for "a coordinated, worldwide, and systematic search for extraterrestrial intelligence." They agreed with Professor Carl Sagan of Cornell that a program costing "a few million dollars per year for one or two decades" could eclipse in thoroughness all previous efforts. "The results—whether positive or negative—would have profound implications for our view of our universe and our selves," wrote Professors David Baltimore, James L. Elliot, Marvin L. Minsky, and Philip Morrison. And time is wasting, they said: the search will become more difficult the longer delayed because of growing radiofrequency interference from civilian and military transmitters.

Three New Professorships Named—and Filled

Three new professorships were announced—and filled—at M.I.T. during the fall. The new chairs and their recipients:

☐ The Quentin Berg Professorship in Mechanical Engineering, to which **Ali S. Argon,** Sc.D.'56, a distinguished scholar in the mechanics of materials, has been appointed.

☐ The Vannevar Bush Professorship, a gift of Dr. Bush's colleagues at M.I.T. and Merck and Co.; **Gerald L. Wilson,** '61, dean of the School of Engineering, is its first incumbent.

☐ The Shell Distinguished Chair in Materials Science, now held by Professor **Ronald M. Latanision,** a specialist in corrosion engineering.

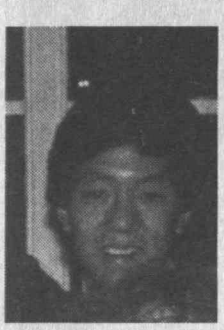
The Berg Professorship, which honors the late Quentin Berg, '37, founder of Berg Electronics, Inc., which is now the Berg Electronics Division of E.I. du Pont de Nemours and Co., is the gift of Frances H. Berg, Mr. Berg's widow. Howard W. Johnson, chairman of the Corporation, recalls Mr. Berg as "that archetypical combination of a leader in both technology and in entrepreneurial management."

The late Vannevar Bush, '16, who was dean of engineering and vice-president of M.I.T. from 1932 to 1938, is honored by eight contributors to the Vannevar Bush Professorship—the Merck Company Foundation; Henry Gadsden, former chairman of Merck and Co., and Mrs. Gadsden; William B. Murphy, John T. Connor, Adolph J. Rosengarten, Jr., and Albert W. Merck, all members or former members of the Merck board of directors of which Dr. Bush was for many years chairman; and Joseph J. Snyder, '44, former treasurer of M.I.T. The chair recognizes Dr. Bush's "important impact on industry and technology and his influences as an educator of engineering students," according to Professor Francis E. Low, provost; and it is just those qualities that recommended Professor Wilson for it, he said.

The Shell Professorship results from a gift of $875,000 from the Shell Companies Foundation, Inc., in recognition of "the quality of teaching and research in materials science" at M.I.T. It is one of a series of five-year-term Shell Distinguished Chairs which the company is funding at U.S. universities in science, engineering, business, and public affairs, intended for "promising young scientists with an established reputation as outstanding performers." Professor Latanision qualifies on the basis of his research and graduate and postdoctoral teaching on corrosion of both metallic and nonmetallic materials, to which he brings sophisticated scientific analysis.

Watching the Campus
Ivan Fong, '83

The M.I.T.-Is-a-Bubble Syndrome



Ivan Fong, '83, is majoring in chemical engineering. He was chairman for 1982-83 of *The Tech*, from which this and subsequent contributions to *Technology Review* are reprinted by permission.

The recent intensity of military conflict in the Middle East and the sudden advent of job-hunting season for many M.I.T. seniors, though not really related at all, jolt me to reality and strike an inner chord to reflect on my seemingly ethereal stay at the Institute.

A common complaint about M.I.T. students is that they don't care about the outside world. Aside from the imprecision of any such generalization, I feel that such a statement does not do justice to the Institute. Most M.I.T. students I know, believe it or not, are fairly knowledgeable on foreign affairs and domestic policy, if not exceedingly opinionated on these topics. This interest, however, and the pursuit of this interest, are sometimes unfortunately put on hold during most of the term.

If one accepts that M.I.T. students are truly interested in culture and the world around them, the obvious reason for this phenomenon is the rearrangement of priorities due to the workload the Institute demands. While admittedly keeping abreast of foreign politics may not be high on any student's list of "Things to Do," it is close enough to the bottom on M.I.T. lists to be among the first to get cut (as does getting eight hours of sleep a night or eating breakfast regularly). It is all too easy, nonetheless, to use studies as a scapegoat for not listening to one's conscience. We all *know* we should read world, national, and local news every day, and many students do (well, most of the time). Yet these are choices students live with, for now.

Despite M.I.T.'s location across the river from the Hub of the Universe, many students hardly ever see it. Perhaps this is reason enough for encouragement of living groups to participate in community service projects, but there is an additional advantage. Visiting a local orphanage or reconstructing low-income housing can be education in itself—learning from the suffering of others. Seeing little children once in a while (for short periods of time, of course) can do wonders for one's outlook on life, as well. Again, however, there is often both little time from lectures and little sympathy from lecturers for such constructive benevolence.

Another facet of the "M.I.T.-is-a-bubble syndrome" comes from a suggestion that students here are not exposed to peer group diversity expected at many colleges—diversity in the sense that one can have dinner with a Renaissance art major or take more than one humanities class a term without people wondering why. The argument that even students at schools large enough to offer such heterogeneity do not take advantage of it misses the point. Large and purportedly diverse universities can serve a distinct educational goal that takes effort to find at the Institute.

The focus of my observations is that students at M.I.T., especially engineers, are, for the most part, training for careers. While there is nothing inherently wrong with career-mindedness, the subtle difference about getting an education lies in the opportunity to enrich one's life. Campus life and educational policy follow trends of pre-professionalism. M.I.T. and its students must be careful not to allow further degradation of non-academic offerings while continuing to ensure a superior classroom environment.

What all this boils down to is the meaning of a college education. No one would suggest that college life simulates "real" life, yet we expect it to prepare one for life. In my view, what is relevant to M.I.T. is the caution that the pursuit of technical excellence not deprive students of faith, curiosity, and perspective. My optimism with respect to the Institute remains. M.I.T. has its share of activists, artists, athletes, musicians, and snobs—they just happen to be scholars as well.

Sports Report
Ken Cerino

One Big Reason Why Athletics Works So Well

Ken Cerino is starting his fourth year as director of sports information; he is currently president of the Eastern College Athletic Conference Sports Information Directors' Association (ECAD-SIDA).

"Hello, amigo," has been the friendly greeting from the M.I.T. sports equipment desk for 35 years—it's John Murphy's way of starting every day.

"Murph," as he is affectionally known, came to M.I.T. in the summer of 1948. "It was going to be a temporary job, working on the grounds," he recalls. But Rockwell Cage was being built during that summer and Murph recalls saying to himself that the Athletic Department might need another person, and "I might be just the man they're looking for." They did, and he was, and Murph found he had a steady job, "and a job that I liked." He took up his new duties in Briggs Fieldhouse "in a coaches' consultation room where we stored all the team uniforms. Later, we put up shelves and moved across the hall into a second room."

Some difference now—"we have a new Athletics Center with an indoor track and ice hockey rink, one of the best all-weather outdoor tracks, new and enlarged tennis courts, a swimming pool which is constantly being used, and a renovated Rockwell Cage—the finest athletic physical plants in the nation today," Murph thinks.

Back in 1948 athletic director Ivan J. Geiger decided John Murphy was just the man M.I.T. was looking for. Now Murph (right), presiding over the equipment room in the du Pont Center, is a legend in his own time.

In these 35 years Murph remembers "plenty of good, tough athletes," and he doesn't really want to single anyone out. Every now and then, though, the names of baseball pitcher Al Dopfel, '72, basketball stars David Jansson, '68, and Dave Koch, '62, hockey and lacrosse standout Ted Madden, '49, oarsman Breene Kerr, '51, track star Al Dell Isola, '50, soccer player Jim Veras, '49, and wrestlers Chuck Seymour, '53, and Tom Gerrity, '63, are heard in conversations around the department. (Jansson and Madden, in fact, are now professors at M.I.T.)

Another name discussed recently was that of John Sununu, '61, the newly-elected governor of New Hampshire. "John played lacrosse here and was a tough, affable, friendly guy," commented Murph. "I'm not surprised he moved ahead in life." (Sununu's son John, a freshman, was a member of the JV soccer team this fall.)

Murph also remembers astronauts Rusty Schweickart, '56, and William Lenoir, '61 (a member of the last Columbia mission). "Athletics helped both those fellows immensely while they were here."

Among Murph's other memories: "We had football in the 1940s with the freshman and sophomore classes playing against one another on Field Day, culmination of the fall season. Rugby was also a real gung-ho sport in those days.

"I'll never forget the night in 1955 when Ike Geiger returned from an Athletic Board meeting. We talked at the outdoor ice hockey rink, and then he went home—and by morning he was dead of a massive heart attack.

"Also at the rink, I used to watch Ben Martin, the hockey coach, skate around with a mask on his face, and all his players with towels over their ears, when it was 7° below zero.

"Once during demonstrations in the late 1960s the police used tear gas outside our building. During the same era, we had women who would jump into the men's sauna with their male counterparts. Now, we have separate saunas for men and women.

"During the oil shortage in the 1970s, a lot of places closed down, except us. We're always open seven days a week during the school year."

Murph remembers that "it was tough when I first started." But his theory right from the start has been to make sure every student remained happy even if he or she didn't receive everything wanted. "I didn't give a lot of stuff away and still don't. We have a small budget. Everything is signed and accounted for, the loss is minimal, and we save a lot of money. We also have our own laundry on the premises."

Everyone remembers how Murph always wants to help. Last year, the Class of 1951 and its rowing Grey Beavers Athletic Club & Supporting Society met for its 30th reunion. Murph was there that Saturday morning at the M.I.T. Boathouse giving out sweats and other gear to Chuck Jackson's group as they prepared for the Charles River workout.

"As for me," he says, "this is my home, and as long as I maintain my health, I'll be happy."

Classes

13 70th Reunion

The Class of 1913 will celebrate their 70th Reunion in June 1983! At this writing, it seems a long way off, but time goes quickly.

At least two members are looking forward to a reunion. **Allen Brewer** writes from Florida: "Well, just eight more months till the 70th Reunion. Maurine and I are planning to be there with you and the rest of the '13ers if all goes well and nobody throws a monkey wrench in our hopes. . . . I had another bout with the surgeons in January. Not serious, just a bunch of vagrant gall stones that became anxious for removal, so we obliged them. No complications, and but for my arthritis I have no complaints. Maurine is also keeping fit. However, she is doing double duty presently, since her sister who lives very near us had a minor stroke a couple of months ago. No paralysis, but troubles with speech and coordination resulted. She is gradually progressing. Maurine does all the driving for both of our households now, and most of the shopping for her sister.

"I continue to write for the *Mirror*. (*Editor's Note*: Mr. Brewer recently had a Christmas poem published in the *Mirror*. If you would like a copy, please write the *Review*.) . . . Incidentally, I was nominated poet laureate for Florida a while back, but the post went to a professor of English at one of the local colleges.

No other news. Seems I have competition in the 'oldest age' group. Anyhow, 93 in June, on Flag Day suits me fine. I'm enjoying every minute still assigned to me. Glad to tell you my recently installed extended wear soft contact lens in my left eye gives me perfect vision. . . . Hope you folks may be favored with a mild winter. This year we had no bad storms, glad to say."

Class president **Walter Muther** still leads a very busy, active life. He writes that he is looking forward to ideas and suggestions for the 70th Reunion. He attends all of the meetings of the Alumni Council which are held at the Faculty Club. He and his daughter, Sally Lawton, had a successful garden. One of his prize plants is "Elephant Garlic." From the picture he sent, it looks most interesting, but I think one clove would be enough for me.

J. B. MacNeill writes: "At age 94 (June 21, 1982) still well and active. Can play my age on a moderate golf course now and then. Mrs. MacNeill (Evelyn) and I celebrated our 66th wedding anniversary on June 28, 1982 and have abandoned wintering in Florida after 18 years of the Miami and St. Pete areas. We like the season rotation. Today is October 11, and western Pennsylvania is beautiful. Good luck to all 1913 classmates. We follow closely their stories in the *Review*.

We have received a notice from the Alumni Office of the death of **Raymond B. Haynes** on September 15, 1982.

We've had a beautiful fall here in Maine. Let's hope the winter will not be too severe.—**Rosalind R. Capen**, Assistant Secretary and Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

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My letter of last October to each person on the latest Alumni Association list of our class had produced eight responses by November 23. I plan to share them all with you as space permits, and I hope that more will come. **Harold Wilkins** phoned that he'd been hospitalized for a long time in 1982, and had been unable to walk. At the time he called, he was walking again, expected to spend much of the winter in a nursing home in Lexington, and return to his own home in Belmont in the spring.

Roswell Barratt writes, "I'm still busy practicing architecture for several new acquaintances and long-time institutional clients. I've just done a new brick house here in Southport, Conn., and recently Trinity Church called me for an historical report (I couldn't remember the whole 285 years!). And since then they've asked for another talk. Has anyone an easy errand to do in western Europe in the coming summer? We expect to be in Hampshire in mid-July, and probably also in Ireland and in southern France."

Francis C. Atwood died on July 31, 1982 in a nursing home in North Falmouth at the age of 89 after a long illness. He was with us in all four years and graduated in electrochemical engineering. After two years as an assistant in physics at the Institute and researcher for the U.S. Government during World War I, he became a partner of the Boston research firm of Kalmus, Comstock, and Westcott, where he developed Technicolor film for the moving-picture industry. After the success of that project, the firm moved to California, but Frank decided to remain in Boston and became chief chemist of Graftex Co., of Boston, in charge of research and development of products which included wallboards, insulation, and coatings. Here he invented and patented the water-based paint later know as Latex, an ingredient of which was the milk by-product casein. He became a national authority on that product and its uses. This led to his becoming director of research on dairy products for Kraft Co., of New York, in a laboratory established first in Newtonville, and in 1934 in Cambridge, as Atlantic Research Associates. He was president of that corporation in 1946. During World War II, when there was a shortage of wool, Frank developed a substitute, known as Aralac, from casein. It was used for soldiers' uniforms. The laboratory originated many other products, including an egg substitute, a synthetic rubber, resin-emulsion paints, and mica specialties.

His interest in young talent led him to cooperate in the work-study program of Northeastern University, employing Henry A. Hill, Ph.D. '42, to direct the students' work. Dr. Hill, a black man, had not been able to get a job in any of the well-known laboratories, but with this start went on to a distinguished career including the presidency of the American Chemical Society. Frank and his family had spent their summers on Martha's Vineyard since 1924. When he retired from Atlantic Research in 1949, he made Edgartown his year-round home, and established a laboratory which was successful in producing a useful protein from waste fish. Later he organized the Atwood Realty Trust, which rehabilitated the Katama area by converting buildings once occupied by the Navy into summer accommodations and a social center, the Katama Shores Motor Inn and Dunes Restaurant. The trust was also effective in restoring old homes in Edgartown.

Frank was a member of the American Institute of Chemical Engineers and several other technical societies, the Sons of the American Revolution, the Edgartown Yacht Club, and the Congregational Church in Edgartown. He is survived by his wife, the former Eleanor B. Bonnar; two daughters, Betsey F. Sylvester, of Harvard, Mass., and Eleanor B. F. Ferens, of Eugene, Ore; six grandchildren, and eight great-grandchildren. He had also shared his home with six children who needed a home and an education.

Freeland H. Leslie died at the age of 91 on July 6, 1982, in Boca Raton, Fla. He was a member of the Harvard class of 1912 and received his bachelor's degree from the Institute with us in Course II. He was founder and chairman of Leslie Welding Co., of Chicago, a manufacturer of ventilating equipment. He was active in the Boy Scouts and was a commissioner of a Chicago-area council. Freeland is survived by his wife of nearly 62 years, the former Via Carter; a son, Carter H. Leslie; and two daughters, Georgianna Middlebrook and Mary Elizabeth Gutsche.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

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Trust all you '15ers are surviving the winter weather and am sure you are ready for spring to appear!

Evers Burtner writes that **John Homan** has enjoyed going to England with his daughter the past two summers. He also says that **Ellis Ellicott** of the Baltimore area flew to Bangor accompanied by his son Charles, and spent a week on Deer Isle, Maine. Then in early September 1982, he enjoyed a fishing trip with some elderly friends, on Parry Sound, Ontario. . . . Evers had a very exciting and most interesting experience in Ontario during the 150th anniversary of the construction of the Rideau Canal. Aboard his Kingston, N.H. neighbor Harry Cards' 24-foot steam launch *Oliver*, Evers was kindly recognized and honored as the oldest participant in the 123-mile cruise from Kingston to Ottawa through 43 hand-operated locks. Out of a total of 28 entries, over half the launches were from the United States (one a 40-foot stern wheeler from Florida) and the rest from Canada. The Canadians were wonderful hosts. Evers notes that the Rideau Canal was built to give an all Canadian water route, Montreal to Kingston and the West, thus making a U.S. attack more difficult.

Have received word that **Raymond O. (Dinger) Doane** and **Virgil E. Warwell** have passed on.

I myself am still on crutches, but, hopefully, by the time these notes appear, my hip will be fully

mended. My very best to all. As always, I am looking for news from each and every one of you!—**Joyce E. Brado**, "Your old Class Agent," 491 Davison Rd., Apt. 9, Lockport, NY 14094

16

While watching TV news from Boston on Thanksgiving eve, we were pleasantly surprised to see and hear **Dan Comiskey** commenting on what it was like in 1910 when he played in the traditional Needham-Wellesley Thanksgiving Day football game. It's the oldest (100 years) continuing high school football rivalry on that day. He looked and sounded great.

From the *Boston Globe* on November 23, 1982, we quote in part: "Captains and players from both towns have been invited back to share in the ceremonies preceding the annual game. Two huge tents will be erected adjacent to the field to accommodate hundreds of former players. The oldest former Needham player present will be Daniel L. Comiskey, 88, a native of Dover who attended Needham High and was a 5-foot, 6-inch, 128-pound halfback on the 1909-1910 team. Comiskey contends that the 1909 game was a 0-0 tie 'played in a snowstorm with three inches of snow on the ground.' The centennial program lists it as 6-0 in favor of Wellesley. Needham won by 6-0 the following year.

Had a nice birthday card from **Joel Connolly** along with an invitation to visit him in Tucson, Ariz. . . . Keep eating, drinking, walking, breathing, everything in moderation, and yes, of course, keep writing.—**Ralph A. Fletcher**, Acting Secretary, West Chelmsford, MA 01863

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A mid-November note from **Penn Brooks** in his Buxton Farm home in Millboro, Vir. tells us: "I head for Sanibel Island, Fla., same old cottage on the water I have had for six seasons." . . . **Warren Tapley** advises that he is still alive at 90 and "must have done something right." He says he "never made much money" and his "little stipend will not do much but it is there every year." . . . **Elmer C. Matthews** of Orlando, Fla., died on July 24, 1982.—**Walter J. Beadle**, Secretary, Kendal at Longwood, Box 217, Kennett Square, PA

18 65th Reunion

When **Charlie Tavener** moved to Boca Raton, Fla., ten years ago, the quiet life of a retiree didn't agree with him. "I don't play golf," he says. "I was going nuts." His solution: to offer his services to the City Council downtown committee. Now, according to an article in the *Boca Raton News*, Charlie is one of the movers and shakers behind the city's downtown redevelopment plan, putting in at least 40 hours a week in meetings and planning sessions as the voluntary acting executive director of the Boca Raton Downtown Redevelopment Agency. "We've got a beautiful future down here. All over, people are going back into cities," he says, visualizing pleasant areas for residents to stroll, sit, and chat with each other in the shade. He wants downtown Boca Raton to be a mixture of business and residential sections, like some European cities. The job is not without setbacks, says Charlie, but he relishes the challenges. "I have a ball down here. The city departments are great—everybody cooperates." We are much pleased with this report of our active classmate.

By now you should have received notice of our 65th Reunion, to take place June 9-10 at the Cambridge campus. We hope everyone can be there for this exciting and happy event. More details will be sent shortly.—**Max Seltzer**, Secretary, 143 Beacon St., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

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A welcome letter from class vice-president **Bob Miller** explained why he and Helen didn't make their usual trip north to Cape Cod last fall. "I was completing my one-year term as president of the Leisure World Men's Prayer Breakfast group and it was amazing all the loose ends and information that had to be passed along to my successor. It was a challenging assignment and rewarding experience. Even with a lot of help, my prime responsibilities included getting top speakers, arranging publicity, and so forth. It felt good to hear so many members say: "We had the best year yet." After Bob finished his assignment, he and Helen spent a week's vacation at Ocean City and Crisfield on the Maryland shore—at hotels complete with front porch rocking chairs and board walks. Bob recommends the Maryland shore for anyone interested in something different. **Helier Rodriguez** phoned Bob in early October on his way to receive the Bronze Beaver award in Philadelphia. The Millers report: "Health okay."

A phone call from **Cac Clarke** late in October told of a phone call from our class agent **Edmund Farrand**. Ed has some health problems like many of us octogenarians, but Cac said he was chipper and in good spirits. Cac and Maxine had dinner at the golf club with Alex and **Munroe Hawes** and reported all was well.

In another phone call to Claudia and **Josh Crosby** just before Thanksgiving, your secretary learned that the Crosbys spent six weeks this past summer at their cottage in Brooklin, Maine. Josh reported reasonably good health and said they had had a class mini-reunion the week before at an M.I.T. club luncheon with a table for six which included Beth and **Whittier Spaulding** and Millie and **Herb Kaufman**. Josh said he read in the August/September 1982 class notes about Ruth and **Irving Jakobson's** trip to New Orleans, Natchez, and Vicksburg. "Dammit," says he, "Claudia and I were in those places at the same time and we never ran into them. If we had only known it would have been such fun to get together with them."

We have three deaths to report this month: **Willard A. Brolin** of Rockford, Ill. on February 18, 1982; **Maurice Basinow** of Lawrence, Mass. on September 4, 1982; and **Luther Goff** of Barrington, R.I. on September 7, 1982. Brolin worked as a mechanical engineer for John S. Barnes Corp. in Rockford, Ill. He was one of those who attended our 60th Reunion. Basinow was chief chemist of the Beach Soap Co. in North Reading, Mass. Goff held various positions in the Brown and Sharpe Co. in Providence, R.I., retiring in 1975 as assistant to the president. He attended all of our reunions through the 25th or 30th and hadn't been heard from since.—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

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Randall "Bunt" Spalding, who has entertained many of us over the years at his Spalding Inn Club in Whitefield, N.H., was presented last fall with the annual Friends of the White Mountains Award by the White Mountains Attractions Association. This award, a Revere Bowl, is given in recognition of outstanding contributions to promotion of tourism and recreation in the White Mountains. The presentation was made by former New Hampshire governor Sherman Adams. Adams referred especially to Bunt's services on the orginial Cannon Mountain Tramway Commission, the Whitefield Airport Development, the Mt. Washington Summit Commission and the White Mountain Region Association.

At last report, **Whit Ferguson** is still confined to the hospital, where all possible is being done to mitigate his right side paralysis and inability to speak. Letters would be welcome; address: Millard Fillmore Hospital, 3 Gates Cir., Buffalo, NY 14209. . . . **Frank Kurtz** tells me that Carlys broke her hip last August, shortly after returning from grand-daughter's wedding in San Diego. As of October, she was walking again with only a cane. Good news. . . . You will be glad to know that **Buck Eacker** has recovered well after a successful aorta operation last fall at Phillips House, M.G.H., and is now back in circulation. He and Peter had a delightful December cruise on the QE2.

My apologies to **Milt Manshel**. I failed to include him and Ruth in the list of those attending our 60th last June. If I missed anyone else besides **Fearing Pratt** and Milt, please let me know. . . . While I did not mention it before, I hope all classmates read the article starting on page A10 of the October 1982 *Review* by **Martha Eiseman Munzer**, "After 60 Years, the Coeds Are Still Dreaming Their 'Impossible' Dreams." My opinion is that **Eric Hodgins** was the best writer our class produced but now with Eric long gone, Martha must move up to number one. Any disagreement?

Several months ago, I reported on **Bill Elmer**, New Hampshire's "Most Extraordinary Citizen." It turns out that he is unstoppable. In October, he presented a technical paper, "The Optics of Reflectors for Illumination," at the 1982 Annual Conference of the IEEE Society for Industry Applications in San Francisco. Recently, in going through the stack of patents in which I was the attorney of record, I find that I prosecuted several of Bill's patents. Why I lost him as a client, I can't remember. . . . **George Dandrew** is in the news again. On October 9, the M.I.T. Alumni Association presented to George its highest award, the Bronze Beaver, at the Alumni Officers Conference in Philadelphia. George is the seventh member of '22 to receive this award. George had done just about averything in alumni affairs. He was honorary secretary in 1937, president of the M.I.T. Club of New York for five years, president of the M.I.T. Alumni Association 1948-1949, and chief marshal at the inauguration of President Killian in 1949. Having been on the track team with George, I well remember his competing in the hammer throw at the 1920 Olympics in Antwerp and his winning the IC-4A hammer throw in 1921 at Harvard Stadium. He spent his business career at Johns-Manville, retiring as vice-president after 42 years. George now lives in Jaffrey Center, N.H., where he continues his work as a marketing consultant.

Recent deaths: **Dewey Godard**, 83, retired since 1959 after a long career with General Electric, died suddenly at home in Marblehead, Mass., last September. Dewey, an electrical engineer, was for many years manager of G.E.'s textile machinery division in Boston. At M.I.T., he was a member of Delta Tau Delta and a member of the Executive Committee of the Electrical Engineering Society our senior year. He was a member of the Tedesco Country Club for over 30 years and a member of the Corinthian Yacht Club for over 50 years. He leaves no immediate relatives other than a brother-in-law, Howard G. Smith, Yale '22, who was a classmate of your secretary at Andover in 1918. . . . **Russell F. Greenough** died May 20, 1982. No other information about him is available at this time other than that he was retired and lived at 41 Dow Ave., Arlington, Mass.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

23 60th Reunion

The quinquennial meeting of the Class will be held on Thursday, June 9, 1983, at 4 o'clock in the afternoon (prior to a cocktail hour in McCormick Hall), for the election of officers, to hear the reports of the Secretary/Treasurer, and for transaction of such other business as may properly come before the meeting.

Francis La Verne Smith writes that he has been retired so long now that he is tired of retirement, and he is glad for TV, stock market,

baseball, and football.

William Glendinning died on September 10, 1982, in Bayside, N.Y. He was born in Maxwelltown, Dumfried, Scotland, emigrated to the United States with his mother and her six children in 1897, and settled in the North Adams, Mass., area and attended elementary and high schools there. He earned and S.B. in electrical engineering from Tri-State University in Indiana, then graduated with our class in electrical engineering, taught as an instructor in electrical engineering at the Institute, and took his S.M. in electrical engineering in 1928. Thereafter he worked first for the Philadelphia Electric Co., then for the Brooklyn Edison Co. as an instructor in the training department, and continued in that field after the company merged with Consolidated Edison Co. of New York. While serving as instructor, director of training and technical employment manager, he also developed and taught refresher courses to prepare engineers for their professional license examination in the State of New York. In 1952 he resigned and devoted his entire time to professional engineering services. He prepared and published six books on the subject of engineering problems which were widely distributed throughout the United States and used extensively by candidates for professional engineering licensure. He was a World War I veteran, served with the 301st Ambulance Company of the 76th Division in France and later with the Army of Occupation in Germany. . . . **Ralph Rubins** died on July 26, 1982. He graduated with our class in Civil Engineering. Thereafter he engaged in general civil engineering work of heavy construction such as railroads, port development, air fields, industrial and utility plants, hydraulic and irrigation projects in the United States and abroad. During World War II he served as lieutenant commander, U.S. Navy, with the Sixth Marine Division on Okinawa. At the end of World War II he was in charge of all preliminary study, master planning and design supervision of all facilities for the U.S. military forces on Okinawa. Later he organized and trained Japanese personnel for the newly formed firm of Pacific Consultants, Inc. For a number of years he was general manager for the design and development of the Aichi Irrigation Project in Japan. The largest irrigation development in that country, this project served as a model for subsequent projects there. He was fellow and life member of the American Society of Civil Engineers.

On November 1 your Secretary/Treasurer was married to Elizabeth Giddings Howland, widow of **Warren Every Howland**, longtime friend and 1922 roommate, in the Phillips Brooks Chapel of Trinity Church, Boston.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

24

Thank you 'mates for contributing so much news for your column. From **Mal H. Finley**, M.D., San Rafael, Calif.: "Just returned from a six-weeks trip on an American President Lines freighter sailing from and returning to Seattle. It included Taiwan, the Philippines, Indonesia, Hong Kong, China and Japan. Went to Seattle and back via Amtrak. Will be going to Panama to visit my son, Douglas, as a Panama Canal pilot, then to Brazil and up the Amazon to its head waters and return to San Francisco via Delta Line, middle January 1983. Marguerite passed away December 6, 1981 from a heart attack, massive pulmonary thrombosis. I was on a 24-day trip to China in April and May with a group."

From **Don Moore**, South Weymouth, Mass.: "The Cardinal and Gray Club (50-year and over grads) had a fall meeting at Endicott House on October 17. Cocktails, lunch and fine talk by Howard Johnson. Our class was represented by Edith and **George Knight** (Pemberton, N.H.), **Don Fife** (Cape Cod), **Ed Moll** (Sunapee, N.H.) and myself." . . . From **Dave Evans**, New Canaan, Conn.: "A note from a still live and kicking ex-athlete. Myra passed away October 29, 1981 after a long bout with arthritis and a short illness. Our three daughters and nine grandchildren gathered, and I was fortunate to have them. Una Cushman died eight days later after a year's stay in a nursing home—a great gal. 'Cush' and I get together and will have to do more in the future. Count me in for '84—the legs still willing."

From **Mark Sinnicks**, Santa Rosa, Calif.: "I've had a pretty rough summer under the care of two doctors for different ailments. I recovered enough so Grace and I could take a trip to Grand Teton and Glacier National Parks the latter part of the summer. So maybe we will be able to make the 60th. Planning a party to celebrate my 80th birthday." . . . **Paul Blampied**, Lanatana, Fla.: "Suffering from arthritis, tenth attack. Practically out of circulation. Most horrible affliction I ever had." . . . **B. Richard Headstrom**, Aiken, S.C.: "I recently signed a contract with Prentice-Hall to do my 23rd book." . . . From Dr. **R. Bruce Lindsay**, Portsmouth, R.I.: "On July 29, 1982 my wife (Rachel Tupper Easterbrooks Lindsay, Brown University, '20) and I celebrated our 60th wedding anniversary." . . . From **Chris Conway**, Pineville, La.: "Still continuing my garden and church work. Active in community theater and concerts. Drive to New Orleans every other month to attend Saenger Theater of Performing Arts and dine at the great New Orleans restaurants. Follow with interest progress of four grandchildren attending college."

From **Harold Banks** to **Don Moore**, Lakewood, Ohio: "Thank you for your 1984 Reunion letter. We see **Bill Ridge** and **George Tapley** about once a year. Liberty Mutual is still taking care of our car and house insurance (expensively). We were up on Cape Cod a couple of weeks ago, but did not have your address with us. Don't count on us for a class reunion." . . . **Fred Terman**, vice-president and provost emeritus of Stanford University is greatly credited for the Silicon Valley's close industrial ties to Stanford and its academic emphasis on electrical engineering. It was his idea to establish 880 acres from the old Leland Stanford farm for business use, including high-tech manufacturing beginning with Hewlett-Packard in the 1950s. Fred was annoyed that his graduates went into exile in the eastern United States, so made the Santa Clara Valley a budding high-tech area. He also established an award at the American Society for Engineering Education to bestow on an outstanding young electrical engineer in recognition of his/her contributions to the profession.—**Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, MA 02168

25

Gilbert Delugach writes from his home in Memphis, Tenn., he is glad he had enough electrical engineering to know what goes on in his pacemaker, which was installed about a year ago. He still plays golf and bridge, and reports that he and Gertrude keep quite active. They have rented a condo in Boca Raton, Fla., for the winter, and I'm sure he has been in touch with some classmates in the area. Gil continues to serve on the M.I.T. Educational Council in the Memphis area.

Ed Kussmaul called me recently to report that he had attended a meeting of senior alumni at Endicott House on October 17, 1982. Ed and Adele found other '25ers present: Ruth and **Arthur Odegard, Anne Levine,** and **Ed McLaughlin**. The Kussmauls left for Briny Breezes, Fla., in December.

At the October meeting of the Alumni Council, I found our faithful officers, **Jim Howard, Courtenay Worthington, Will Gardiner,** and **Ed McLaughlin**. Our honorary classmate, **Joe Martori**, was there too, busy as usual.

It is with sorrow that the passing of **John E. Yarmack** must be reported. We have had no address for John for several years; he died at 126 Elm St., San Mateo, Calif.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

A most successful Cardinal and Grey Society Luncheon for senior M.I.T. graduates and widows was held at Endicott House on October 17, with Dr. Howard W. Johnson as guest speaker. The increasing popularity of these gatherings was demonstrated by the number of participants—150, including our classmates Evelyn and **Bob Dawes** (the sponsor), Mary and **Don Cunningham**, Ruth and **Bob Dean**, **Stark Draper**, Jeannette and **Al Lamoureux**, **Mrs. Richard B. Parsons**, Mary and **Dwight Taylor**, and **Mrs. George W. Wardner**. I enjoyed talking to our classmates and other alumni—we all have so many varied experiences and attitudes. A few regulars were missed such as **Marvin Pickett**, who compensated by calling later for a chat. He mentioned that he had attended the 50th wedding anniversary of the **Chester Petersons** in Chevy Chase, Md. He also furnished **Bill Hoar**'s new address: 2528 Ross Rd., Silver Springs, MD 20190; it appears that world-wandering Bill is now settling down near some of his children and grandchildren.

A note from **Elton Staples**: "Another fine summer in Chatham is over. We were happy to greet many classmates here at our 55th Reunion a year ago; now we leave for Winter Park, Fla., and would be glad to see you there, too. Our family is foremost in our activities—three sons (two M.I.T. grads), eight grandchildren, and three great-grandchildren. Helene's art keeps her happy, and I enjoy gardening."

An article from the *Cape Cod Times* reports the death of **Charles E. Keniston** in August. He retired in 1967 after working 40 years for Lever Brothers as plant manager in Cambridge and Baltimore and as executive plant manager at their headquarters in New York. He had been elected to the International Executive Service Corps and served in Thailand and South Korea for that agency. He is survived by his wife Ruth V. of South Yarmouth, two daughters, one sister, seven grandchildren and three great-grandchildren. . . . A note from Paul Damon advises of the death of his father, **Russell L. Damon**, on September 11, 1982, at the age of 82. . . . Also, a letter from Mary P. Milmine advises of the death of **George Parsons Milmine** on September 24, after a long illness.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 021168

27

The New England Aquarium paid a tribute to professor emeritus **Harold E. (Doc) Edgerton** on October 25, 1982 with the establishment of a $1 million Edgerton Research Endowment. His fascination with the sea inspired the Aquarium in 1969 to open the Edgerton Research Laboratory. Projects have included environmental studies of Boston harbor and investigations of natural wildlife desease. Income from the fund will support young scientists in oceanographic research.

Katherine and **Russell Westenhoff**'s daughter, Judith, was ordained a Presbyterian minister on November 7, 1982 at the Madison Avenue Church in New York City with the **Anson Rosenthals** and **Kenneth Smiths** attending the ceremony. Russ has had to take 33 radiation treatments for a malignant prostate lump. The doctors say the treatment should cure his problem and he does not need surgery. He feels fine and has no bad effects from the radiation. . . . **Theodore Ordman** is enjoying retirement in Stanfordville (Duchess County) N.Y. with plans for a period of warmth in Florida when the snow begins to fly. He was sorry to miss our 55th.

George Cunningham enjoyed the annual

M.I.T. Mexican Fiesta held in Yucatan last fall. He again (14th year) was "Andrew" in da Vinci's *Last Supper* presented for seven weeks by the Laguna Beach Festival of Arts last summer. As Santa Claus for 760 kids December 7-24, he never runs out of candy canes. . . . **George B. Darling** of Hamden, Conn. has had a most distinguished career and is professor emeritus of human ecology at Yale. As director of the Atomic Bomb Casualty Commission from 1957-1972, he supervised a group of 700 doctors and scientists in Japan and the U.S., studying the human effects of the bomb in Hiroshima and Nagasaki for the National Academy of Science. From listings in *Who's Who*, we learn he has received numerous awards and honors from health organizations in Japan and the U.S. With all the current discussion on nuclear disarmament, George can be gratified that he has contributed to the human disaster story from nuclear explosions. Doctors, clergy, engineers, and scientists of the world unite for control of nuclear armament.

Arthur B. Guise of Marinette, Wisc. died on August 24, 1982. As a chemical engineer he worked on research in petroleum refining until 1936 and since then had been involved in fire protection engineering. Since 1942 he was chief engineer and later research director of the fire extinguishing division of Ansul Chemical Co. Arthur was a member of National Fire Protection Engineers and listed in *Who's Who in Fire Protection*. He had written various articles and served as a contributing author to *Safety in Chemical Operations*.

D. Anson Rosenthal of New York City died on November 14, 1982 from a heart attack. He had been ill for a long time and wore a pacemaker. Rosie was a colorful and party-loving classmate. Over the years he was active in meetings with New York City '27ers—the late **Russ Westerhoff, Jim Lyles, Bob Bonner, Joe Harris**, and **Glenn Jackson**. In 1951 he became a Broadway "angel" with his future wife Naomi Sherman in backing a musical production. They were married in April 1966 which prompted **Ezra Stevens** to toast him thus: "You can't but admire a man who takes all the time necessary to make the correct choice of wife even if he needs 40 years to decide." Our sincere condolences to his patient widow Sherry.—**Joseph C. Burley**, Secretary, 5 Hutchinson St., Milton, MA 02186; **Laurence B. Grew**, Associate Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Associate Secretary, 2150 Webster St., Palo Alto, CA 94301

28 55th Reunion

Once again, we thank all of you who responded so loyally and graciously to our telephone calls from the Institute during the October Telethon. The '28ers who met at the Alumni Center to make the calls were: Frannie and **Jim Donovan, Fred Lewis**, Ruth and **Abe Woolf**, and Florence and **Walter Smith**. Alumni support to M.I.T. is vital, and we are pleased to report that our class invariably does its part very well.

Earlier in October the Donovans were on a two-week business trip to Japan and Korea. It was a most interesting experience that included visits to Tokyo, Kyoto, and Hiroshima. They were especially impressed with the beauty of the country, the modern active cities, the bullet trains (160 miles per hour), Mt. Fuji, and the white-gloved bellmen and taxi drivers. Jim tried to contact **Shikao Ikehara** but, unfortunately, without success.

As of this writing, plans for the 55th Reunion, June 8-12, on campus in Cambridge are going forward in good fashion. By the time these notes are in your hands, you should have received a program outline and a list of those hoping to attend. If your name is not on the list, act now! Don't miss this one!

Jack Rouleau has an excellent sense of humor, and his most recent letter shaded from funny to punny. He did apologize (sort of) so presumably that made everything okay. However, when you talk with him in June be on the alert! . . . **Roberta Halligan** says that her present activities include the presidency of her area chapter of the American Association of Retired Persons. . . . **Alex Daytz** assures us that he will be there in Cambridge for the 55th. . . . **John Houpis**, writing from Athens, Greece, says he would still like to find a retirement spot in the U.S. He was much interested in **Fritz Rutherford**'s move to a retirement center in South Carolina. . . . **Bill Hurst** continues to be one of our faithful correspondents. He has some good thoughts on a variety of subjects, and we are sure you class philosophers would enjoy talking with him at the reunion.

With deep regret we must report that **Thaddeus L. Sharkey** died on September 15, 1982 following a heart attack. Thaddeus studied in Course XV (Business and Engineering Administration), then earned a law degree at the National University law school. An obituary in the *Washington* (D.C.) *Post* of September 20 tells us that his first job was with the Washington Railway and Electric Co. This was followed by a position with Potomac Electric Power Co. He served in the Navy during World War II and rose to the rank of lieutenant commander. He joined EBASCO Services in 1950 and retired in 1979 as a company official. To his wife, Annabelle, and family we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Anthony Standen of South Kent, Conn. says that he is doing volunteer teaching in mathematics in the local public grade school. He also plays with and entertains children in the local day-care center. His remaining leisure time is devoted to the opposition of nuclear plant proposals or construction.

Charles W. Sampson of Rochester, N.Y. and his wife Sigrid recently celebrated their 50th wedding anniversary. . . . **Henry S. Muller** of Belmont, Ohio and his wife Natalie manage their tree farm. "Nothing new with us, just growing older." . . . **Rolf A. Zurwelle** has moved to Richmond, Va. and is continuing his company of products design and engineering. "Thanks for the birthday card from the Class of 1929 which is most appreciated on my 67th year." . . . **Anthony J. Perry** of Moneta, Va. writes, "Thank you for remembering my birthday. Ruth and I are all settled in our new home here and enjoy the country environment. I am 99 percent retired, just a few items to finish. We both are well and looking forward to our 55th Reunion. Our best wishes to all."

Mary and **Frank Mead** live in the best of two worlds—Marion, Mass. in spring and summer and Northport, Fla. in fall and winter. A note from Mary states, "It was very enjoyable being with the 55th Reunion committee, a fun group, and we certainly made headway on our plans for 1984. With three couples from our Marion golf club, we went to Lifton, England, a small town about 250 miles from London. The girls did some shopping and sightseeing while the men went fishing for salmon, but did not even see one. They did, however, catch some seatrout which were delicious at breakfast. In Florida, Frank manages 'Mead's Marauders,' a group of 40 golfers every Monday and Friday."

Adrian (Cub) Clark of Woodbury, Conn. and his wife hope to celebrate their 50th wedding anniversary on December 3. He has switched from working with elementary school LDs (students with learning disabilities) to interviewing AFS (American Field Service) applicants in the local regional high school. . . . **Bill Baumrucker** of Marblehead, Mass. says he is still good for tennis and is not old enough yet to take up golf. He and his wife Doris together with **John Rich** and wife Olive flew to Ireland last September, hired a car, and drove 1,500 miles seeing all the worthwhile sights, meeting wonderfully nice people. He says, "It rained all but one of the 18 days of our trip, but that is what keeps Ireland green—and it surely is green!" Last June, he and Doris together with three other couples from Marblehead chartered two 54-foot sailboats and cruised the southeast coast of Turkey for two weeks. The boats are based in Cypress and their owner-captains knew those waters well. And the great hostess-cook on each boat fed them well. "It is a facinating, beautiful, and little-visited part of the Mediterranean. The way we did it is the right way and I highly recommend it. Doris and I came home by way of Morocco. She has always wanted to get into the Kasbah in Casablanca. Casablanca wasn't so much, but we spent four days at Marrakech, 200 miles inland at the base of the Atlas Mountains. That and some of the other Moroccan cities and countryside I would like to get back to. Best wishes to all."

I regret to report the deaths of the following members: **Joseph A. Bonner** of New Haven, Conn. on November 11, 1975, **Charles Lukens Huston, Jr.** of Villanova, Pa. on October 1, 1982, and **Newell W. Mitchell** of Southbury, Conn. on October 26, 1982. Charles Huston was the retired former chairman and chief executive officer of the Lukens Steel Co. He was associated with the steel industry for over 50 years. He was an active member of American Management Association as well as the National Association of Manufacturers. During World War II, he served as an industry panel member of the National War Labor Board. . . . A note from **Norman M. Wickstrand** of Harwington, Conn. announces the death of his friend and classmate, saying, "It is very sad for me to report the passing of one of our classmates and a friend. About 20 years ago, I met Newell Mitchell in one of the Appalachian Mountain Club activities. I learned that he went to M.I.T. (Course V). He and his wife attended our recent 50th Reunion with me and my wife, and we visited the M.I.T. campus and participated in many other activities. Newell and I shared many common interests together, such as the Appalachian Club, Audubon Society, and Connecticut Forest and Park Association. We also played chess together often. He also played chess by correspondence, although I never did. I still enjoy playing chess and try to solve some of the problems in Dr. Gottlieb's puzzle corner in the *Review*."—**Karnig Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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A newsclip from the *Bennington* (Vt.) *Banner* reports an exhibit of **George Holt**'s color photographs last September and October. According to the newsclip, George's background as a painter and designer led him to concentrate on color photography, "where he finds exciting combinations of color, texture and light among still-lifes, interiors and snow scenes. His photographs are related to abstract painting, especially through their color and composition." After graduating from M.I.T., George traveled extensively in Europe; upon his return he became assistant to Edward Forbes, director of the Fogg Museum at Harvard, where he assisted Forbes in teaching a course on methods and materials of medieval painting. In 1938-39 George spent some time in Istanbul working on the conservation of mosaics in the Church of Hagia in Sophia. From 1941 to 1968 he taught art at Bennington College. After his retirement from teaching he concentrated on photography, and has exhibited his work at a number of New England galleries. For a number of years George has owned and operated the Walloomsac Tree Farm (Christmas trees) just across the New York state line from Bennington. . . . **Earl Ferguson** reports that his daughter Priscilla is now president of the Board of Directors of the YWCA of Orange and Essex counties, N.J. Earl recently served as chairman of a film council seeking to get theatres to improve the quality of the children's films they screen. He recently received a letter from **Fran Burley**, who apparently is still carrying on the teaching program in Indianapolis that he undertook upon retiring from Western Electric. . . .

Ernie Fell retired from the practice of medicine in 1967 and has "lived happily ever since." He quotes Charles Lamb to the effect that he now has "the joy of walking about and around instead of to and from." . . . As previously reported, **Leslie Ferrier**, after retiring as chief electrical engineer of Creole Petroleum Corp. in Venezuela in 1961, returned to Massachusetts and thereafter successively took over the management of the Middleboro and the Mansfield municipal electric systems until his final retirement in 1974. Since then his activities have included "electronic tinkering," working with his TRS-80 home computer, and responsibilities in the Taunton and Mansfield Rotary Clubs. Leslie laments the fact that he was forced, for financial reasons, to drop out of M.I.T. for a year after his junior year and is thus somewhat out of phase with both the class of '29 and the class of '30. His advice to newcomers is "to complete their scheduled course *on time* if they have to hock their shirts to do it. Never, never skip a year. You pay for it the rest of your life!"

We have received notices this month concerning the deaths of two of our classmates: **Dominick Mastrangelo** on February 25, 1982, and **Brig. Gen. Herbert Ehrgott** on September 20. Unfortunately, I do not have anything in my records about Mastrangelo. General Ehrgott was a 1926 West Point graduate who received a B.S. in mechanical engineering with our class. He served in the Corps of Engineers in North Africa during World War II and joined the Air Force when it became a separate service in 1947. In the '50s he commanded an aviation engineering battalion in Texas, and was stationed in France at the time of his retirement from military service in 1956. Thereafter he worked as a civilian for five years in France and Viet Nam for the engineering and architectural firm of Tippetts, Abbott, McCarthy and Stratton. At the time of his death he was a widower; he is survived by three children and two grandchildren.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06588

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Here it is the end of November and the class notes for the February/March issue are due. **Ben Steverman** is a life saver this month with the following letter: "At long last I have something worthwhile to contribute to the *Review* notes. The Cardinal and Gray Society luncheon on Sunday, October 17, at the Endicott House in Dedham was a delightful affair, with the Class of '31 well represented by: Mildred and **Wyman Boynton**, Mary and **Gene Branca**, Mrs. **Madison (Maddy) Cannan**, Mrs. **Vincent Damiano**, Polly and **Ken Germeshausen**, Gertrude and **A. L. (Hessie) Hesselschwerdt**, Clare and **Ben Steverman**, and **Harold Wilson**, who came down from his farm in Bolton. (Looked as though the country life agrees with him.) . . . Wyman tells me that he sees **Johnny Harrison** occasionally up in Durham, N.H., and that he also follows Johnny's letters to the editor, which appear rather frequently in the local paper. Knowing Johnny's willingness to take the opposite side of almost any argument, I can well imagine that the correspondence to the editor would be somewhat controversial and most entertaining.

"Polly and **Ken Germeshausen** are enthusiastic about the responses they received for the Alaskan cruise in June. Eighteen couples are planning to go, and Polly and Ken are looking forward to this mini-reunion.

"On a more personal note, our youngest daughter, Betsy, was married on June 26, so that Clare and I are now the only ones at home in Plymouth. All six of the children (five daughters and one son) and all 12 grandchildren came home for the wedding so that we had a house overflowing with kids and friends and celebration."

A note from **Emile Grenier** says that 1982 started on a low note because of something wrong in his throat. "An examination revealed a malignant tumor on my larynx. Several days before radical surgery, it was decided to use radiation. On March 18 I began a series of 36 daily treatments on a linear accelerator x-ray machine at Saint Joseph's Hospital here in Ann Arbor. Up to now five examinations so far have indicated that it is gone, but they will look every month for a while yet." You have all of our best wishes, Emile. The rest of Emile's letter tells of his presentation of a Ford Tot-Guard to Prince Charles and Lady Diana for baby, and the thank-you note they received from Prince Charles. Going on, it tells about their relatives visiting them during 1982 and their trip overseas. It is always good to hear from Emile; his letters are always interesting and greatly contribute to your class notes.

Now for the sad part of our class news. Word from the Alumni Association office indicates that the following classmates have passed away: Captain **Francis X. Forest** on June 4, 1982, in Belfast, Maine; **John Lyon Reid** in September 1982; **Davis D. Lewis** on July 28, 1982; and **Morton B. Curley** on July 20, 1982. Morton is survived by a daughter, Margaret; his widow Natale Curley; and his grandaughter, Katie, who has just entered her first year at Andover Academy. Our sincere condolences are extended to all relatives of these classmates.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

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Usually the class committee and officers are persons that live fairly close to M.I.T. so that meetings and duties can be properly attended to. When **Donald Brookfield** sensed the difficulty of getting a candidate for class president he decided in a spirit of service to accept the nomination for president. That spirit of service is a strong motivation for Don. When he and his wife Phyllis were busy bringing up six children in Sharon, Mass., they realized that their Unitarian Church was past its prime and was not attracting the younger people. In 1974 they decided to put their shoulders to the wheel because the church had good values for people in general and children in particular. First they brought a young married minister to Sharon, who lived with them until a proper parsonage was acquired. Then they designed and pushed the building of a reformed Sunday school with the church. Don was also very active for many years on the town of Sharon finance committee. He saw to it that a large high school auditorium was built so Sharon could preserve its town meeting character.

Don and Phyl have for a long time been aware of the misery and starvation throughout the world. Because they realized that charitable contributions help to alleviate some of the misery but do not solve the basic problems, they are today contributing their efforts toward world population control and planned parenthood. I asked Don how Brookfield Engineering Labs got started. . . . In 1934 he was working for Gillette, while his father was an accountant for a chemical company that came upon very hard times largely because their product would solidify and be returned to the factory. The company's technician complained that he needed a dependable viscosimeter. Since Don as a boy always wanted to be an inventor, he investigated the situation and decided he could come up with a much better instrument. After many evenings working on models, his 24th motor instrument was good. General Electric purchased it and recommended it to other companies. Fine interested people formed a company and sold several instruments. When improvements were made they replaced all older models at no cost to their customers. The first year he figured they made 25 cents an hour for their work—but they did penetrate the market.

In 1939 a chap offered $5,000 for half interest in the company. It was refused because they were afraid the chap would lose his money. But then during the war they received a 3-A rating from the government because their instruments were important for the production of coaxial cables and cathodes for airborn radar. From this point they grew into a highly-specialized international company.

Through the years Don and Phyllis have also found time to bring up a large family, travel, and enjoy many hobbies and sports. . . . As class president Don hopes that in due time some class activities and mini-reunions can be worked out before we start thinking of the 55th.

I have received several notes from our classmates which I will pass on in the next issue. . . . For now I must pass on the sad news that **G. Dewey Goddard**, of Marblehead, Mass. died September 5, 1982. He retired from General Electric in 1959 after many years of service as manager of the textile machinery manufacturers' division. He leaves no immediate relatives. . . . We also learn that **Donald W. Fetters**, of Hendersonville, N.C. died on May 21, 1982. We await further obituary information.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33 50th Reunion

Correction: The report in the January 1983 issue regarding the sale of Chatham Bars Inn was in error. It has been reserved for our reunion.

A couple of follow-ups to last issue's column: First, a short note from **Jack Andrews** tells us that he saw **Bill Baur** and **Mel Eherlich** at the Alumni Officers Conference that Jack attended in Philadelphia a short time ago. I can understand why Mel attended, as he and Jack live only a few miles apart. And Bill, of course, lived for years in the Philadelphia area, until his retirement from G.E. He also spends part of his summer in New England, this year attending several wedding anniversaries, so the conference was just part of Bill's trip from Florida. . . . We have another item to clarify: **Bill Harper**'s "yard boss," an expression that needs explanation. Bobbie is yard boss of a 20-acre tree farm, part of which she owned way back, with the remainder purchased later. This plot became a tree farm with capable supervision, which is where Bobbie comes in.

Lennox H. Lindsay of Laramie, Wyo., writes: "I have been retired since 1967 from G.E. Married Gertrude in 1975. We fly-fish, play golf, and ski and we are both members of the National Ski Patrol. We expect to be at the 50th in 1983." . . . Next we have a born post-card writer in **Mal Mayer**, who writes several times a year. He writes from Antarctica that he is as far from home as he can get—south, at least. We all appreciate Mal's cards, no matter where they're from.

We are fortunate to have only one classmate gone to his reward. A long clip from the *Washington Post* of September 28, 1982, tells us of the passing of classmate **Leo Goodman**. Leo moved to Washington in 1934, and got into the nuclear issue in the late 1940s, when he tried to improve worker housing at Oak Ridge, the site of huge government nuclear activity and research. Apparently, too many workers were getting nuclear sickness. In 1947, he joined Walter Reuther's United Auto Workers, setting up their Atomic Energy Committee. In an article several pages long, Rabbi Joshua Haberman pays fitting tribute to this really talented man. He was said to be very articulate, learned, and way ahead of his time.

Please note that this column is the shortest that I have ever turned in. I am assured by older secretaries that this situation is not rare. Please don't think that my writing is primarily to raise funds for the 50th Gift. No, folks, I am not a fund raiser, but I am a news raiser, and I can't do it without some help from those who have personal news, interesting to all of us. Better watch out—there is a rumor that you will have a new Secretary to ignore after June 1983.—**Warren J. Henderson**, Secretary, 6015 S. Verde Trail, St. Andrews S., Apt. L-315, Boca Raton, FL 33433

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Possibly the result, in part, of filling in for me occasionally, **George Bull** is always faithful in reporting on trips that he and Mary Elizabeth take. They have finally had a chance for a long-desired look at East Germany. George writes: "When I was in the government and living in Germany, the East Zone was a real 'no-no.' For a long time Mary Elizabeth and I have rather wanted to visit Dresden and Leipzig. My mother had spent a winter in Dresden and her father obtained his Ph.D. with the famous Ostald in Leipzig. I had been out of the government long enough to go there, so I applied for a visa and paid for my hotel rooms in advance, as is required, and off we went for five days in the two cities. This was part of a trip to Europe that was spent mostly in West Germany and Holland."

"I found the country much more prosperous than I had imagined. Lots of private cars and people in restaurants. We did not feel any restrictions, and we circulated around in the cities very freely. When we asked about a trolley ride to see some of the suburbs, the hotel desk clerk gave us an excellent suggestion how to spend an interesting day going up the Elbe on the car to a certain castle and coming back to the city on a boat. At the border our luggage was not examined nor were we asked about the money we had with us."

"On the other hand, the shops did not seem to have a variety in the quality and price of goods. You could get something, but that was it. We noticed the difference when we returned to Frankfurt/M where we saw large department stores lined up and offering a variety. The hotel in Dresden was clean and comfortable, as are all German commercial hotels built in the last 25 years. In Leipzig the Hotel Mercur was built for people to stay in while at the famous Leipzig Fairs. It is the most luxurious hotel that I think I have ever been in. In the ice cube rooms that hotels often have on each floor there was not only ice cubes but soda on tap, too."

Along with his letter George included a clipping from the November 11, 1982 *Boston Globe* that had been sent to him by Al Mowatt, '35 secretary. Unfortunately, it concerned the death of Dr. **Arthur Miller** of cancer in Beth Israel Hospital. Art had been a familiar attendant at our reunions, but I doubt if many of us knew the breadth of his career. At 14 he had started his own radio repair business in Boston. He joined the Sanborn Co. in 1936 and two years later obtained his Sc.D. degree, also from M.I.T. During the war he was a physicist at Carnegie Institute in Washington and a research associate at M.I.T. It was during this period that he took part in the development of radars and followed that up with work at the Office of Scientific Research and Development. He continued at Sanborn and was director of research when it merged with Hewlett-Packard in 1961. He became chief engineer and director of research of Hewlett-Packard's medical products division in Waltham. In 1969 he left Hewlett-Packard to set up his own consulting business in the field of medical electronics.

Art held memberships in the American Association for the Advancement of Medicine, the Instrument Society of America, and in 1971 was elected a fellow of IEEE. He was a past president of the Stein Club and a member of two Israeli university groups. He is survived by his wife Rose, a son, twin daughters, and three grandchildren. To Mrs. Miller I would extend the sympathy of us all on her loss. We will miss a faithful class member.

There are a scattering of Alumni Fund notes. One from **Bill Schumacher** reads, "Have been missing the class notes. Hope our Secretary is okay. (Yes, he is. Apparently we both took off at the same time.) Don't remember seeing mention of the demise of **Draper Williams** in September 1980 although I passed the word along at least once in the interim." (I'm sorry about Draper's loss and our apparent oversight, but I don't ever recall hearing about it. I checked my *Alumni Register* which I keep marked up and found no indication of being notified.)

Walter Hofmann drops a line from California. He says, "No exciting news from Silicon Valley. Edith (my better half) and I are enjoying good health. I've just had cataract surgery, left eye with an intraocular implant, and the results are excellent. The welcome mat is out here in Sunnyvale where we have some of the best weather in the world."

Finally, Father **Joseph Hahn** sent on a clipping from the *Maryknoll Magazine* that covers both the highlights of his varied activities with that order and some of his latest travels. In the last year he visited Africa to cover the first anniversary of Zimbabwe's independence, Puerto Rico, and by this writing has probably completed a planned trip to Venezuela.—**Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.) Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015

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Betty Beckwith, lovely wife of our good friend and classmate **Leo Beckwith**, died Sunday November 14th after a long and miserable bout with cancer. She added something very special to our reunions and class affairs and we shall all miss her tremendously. Our deepest sympathy goes to Leo and his family. . . . Willard L. Munro, '27, sent me a note from the *Colgate Alumni News*, that his cousin **Isaac Hill Munro**, Colgate '33, who received his masters in chemical engineering with us, died July 5 in Ft. Lauderdale. I am sending a note to his widow, Claudine B. Munro, 1777 S. E. Tenth St., Ft. Lauderdale, FL 33316. . . . As I was completing these notes I learned of the death of **Jack Colby**, who had a heart attack at his home in Islamoranda, Fla., on November 27. He and Priscilla only recently returned from an extended trip through the Scandinavian countries, Holland, and Belgium, where their son lives. I am extending our deepest sympathy to Priscilla and their family. Another person we shall miss at our reunion.

The M.I.T. Club of Mexico announces the 35th Annual M.I.T. Fiesta in Mexico from March 4 through 9, 1983, being held in Oaxaca this time. . . . **Richard F. Jarrell**, principal scientist for the Jarrell-Ash Division of the Fisher Scientific Co. and Allied Corp. of Waltham, was named recipient of the 1982 Award of Merit by ASTM during ceremonies in Boston on October 5. . . . **Les Brooks** reports from Rockmart, Ga.: "We're fine and have nothing unusual planned for this fall or winter except to join our daughter and family in Memphis for Thanksgiving and Christmas."

Kay and **Chet Bond** moved to Belleair, Fla., a short time ago for their second winter there. Chet brags about the choice of location and the weather they get facing the Gulf: in the 70s, which "will last straight through to May." Chet is our new Class Golf Champion, having won the final round over **Bill Gross** by "staying in the middle most of the time" on his first round on the difficult course of 36 holes which adjoins his abode on three sides. He gets his name engraved on the President's Cup and keeps it for a year. Three wins and the cup is retired. **Bernie Nelson** will be happy to learn no one has more than one leg on his trophy so far.

I participated in the M.I.T. Telethon in October with **Ben Blocker**, and particularly enjoy it because I usually get a chance to talk with some of our classmates. Before we got started Ben told me he is semi-retired since he sold his interest in his company of 35 years, Bender Products, in July 1982. His wife, Hadassah, is Radcliffe '35. Their son Richard got his M.D. in six years at Boston University and is a pediatric ophthalmologist and father of four. Their other son, David, is a Harvard graduate, father of two, and in research in education. . . . **Bud Pflanz** was another classmate I talked to. He has moved to 3623 Shawnee Dr., Sierra Vista, AZ 85635. That is located 70 miles northeast of Tucson. His roommate is a 21-pound Burmese cat! He said he moved because his next-door neighbor back in New Jersey sold the snow-plow with which he usually plowed out Bud's driveway. (Another good reason: his children all live in the southwest.) . . . I indulged myself this Thanksgiving by going to see the Swampscott-Marblehead football game—the 76th meeting of the two. Fifty-two years out of high school and I saw only one other man from my class there. A few years ago—about 30 to be exact—it used to be like a reunion! I joined the rest of my family at son Christopher's and Kay's home in Newburyport for the traditional turkey dinner. My two granddaughters, 3 years and 4 months helped to spice the proceedings. Missing was daughter Pamela, who is trucking with Rich and my third granddaughter to Los Angeles and back. What have you been doing?—**Allan Q. Mowatt**, Secretary, P.O. Box 92, Newton, MA 02195

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For the second issue in a row we can rejoice in the fact that we have not learned of any diminution of the class ranks. Some of us may be getting stiff and creaky but we're still functioning.. . . Traveling to West Hartland on October 30 were Pauline and **Ken Arnold**, Harriet and **Dana Devereux**, Vivienne and **Eli Grossman**, Rilla and **Walt MacAdam**, Virginia and **Augie Mackro**, Lillian and **Larry Peterson**, and Phoebe and **Frank Phillips**. After lunch and before our afternoon walks, Walt MacAdam gave us a very interesting presentation on "New England's Electric Energy, Past, Present, and Future" illustrated with charts and diagrams. Walt chairs the Energy Committee of the New Hampshire Legislative Academy of Science and Technology. He discussed the role of nuclear energy in reducing dependence on oil. . . . Dana Devereux talked on the problems of investing and there was an animated discussion on the subject. **Pete (F.S.) Peterson** had sent along his "Miscellaneous Comments on Playing the Stock Market," which were welcome. It was too bad he could not have presented his views in person.

We all enjoyed the various letters which Eli and I had received from classmates who were unable to attend. The most intriguing is an anonymous postcard from London where some '36er was enjoying the theatre and taking courses in history at Oxford. If he (and I assume it was a "he") wants us to know more about the stay in Great Britain he will have to provide more details including identification! On September 16, Dottie and president **Tony Hitti** were in Peking, having traveled by train across Europe and Asia. They should have an interesting story to tell.

Fletch Thornton, who at the last moment couldn't make the "mini," wrote that he and Peg had had a visit in Vermont from Mary Lou and **Gordon Thomas** who were en route from Marco Island, Fla., to their cottage north of Montreal. The youngest Thomas offspring, a son, is at the University of Florida where he plays water polo. . . . **Pat (J. F.) Patterson** with Marion and daughter Marcia departed October 28 for a trip to China, going first to Hong Kong and returning via Tokyo. Although Pat retired from Union Carbide's Linde Division at the end of 1981 after 45 years and five months he continued for another six months of additional work. Do you suppose he's really retired yet?

Virginia and **Dick Denton** had hoped to get to West Hartland but had had their fill of travel with two unplanned trips from Marlton, N.J. to Newport after their boat broke away from its mooring and went ashore. It was retrieved with only minor damage. Dick reports that their son Peter is now the president of Denton Vacuum but Dick still finds much to attend to, particularly trying to increase the output and yield of Denglas. This past year he has broken a wrist playing ice hockey. He also practiced too much for tennis, and paid for it with severe and painful arthritis in his right elbow. Then he bruised his thigh when he tripped over a skid at the plant, but he's now jogging again!

Whew!

John Rowan writes that he is now really retired, having finished up his consulting work, and is enjoying winters in Clearwater, Fla. and summers on the Saint Lawrence in Ontario. . . . Your secretary is as busy as ever, but she always has time to read mail—so do drop me a line and tell me what you are up to.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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Harry N. Wallen writes: "Retired from the Navy as a rear admiral (Civil Engineer Corps) in 1968. Retired from Bechtel Corp. in 1978 after ten years with the company. Now doing some consulting work, but mostly travel and golf. Visited South Pacific bases in April 1982 with members of my Seabee Battalion (First NCB) after a 40-year hiatus. We were royally received by the King of Tongo and by the President of Vanuatu (formerly New Hebrides). Wonderful trip." . . . **Karl P. Goodwin** of 12 Fort St., Fairhaven, MA 02719 retired June 1982 as chairman of the New Bedford Five Cents Savings Bank board of directors. He continues to serve as a member of the bank's board of investments and as a consultant. Karl was formerly executive vice-president and general manager of the Acushnet Co., where he worked 32 years, resigning in 1970 to become president and chief executive officer of the bank. He was elected chairman in 1980. He is trustee and vice-president of St. Luke's Hospital, director of Investors Bank and Trust Co. of Boston, director of United Way of Greater New Bedford, Inc., and an investment committee member of the old Dartmouth Historical Society, a former director of the New Bedford Area Chamber of Commerce, and a former trustee of the Southeastern Massachusetts University and its building authority. He is past president and a director of the Wamsutta Club. He is a graduate of the Advanced Management Program at Harvard Business School.

Gilbert C. Mott of 95 Sycamore Lane, Fairfield, CT 06430 retired February 1, 1982 as vice-president of planning for the Olin Corp., Stamford, Conn. After graduation he joined Bridgeport Brass Co. and rose through the ranks to vice-president for engineering and research. He served as a lieutenant in the U.S. Navy 1942-46 assigned to naval ordnance. He joined Olin in 1968 as vice-president, Aluminum Division. In 1971 he was elected a corporate vice-president and appointed president of the Aluminum Group. He became vice-president of planning of Olin in 1974 after the sale of the aluminum business. He was recently named director of development of the Bridgeport Engineering Institute. He is a director of Raybestos-Manhattan Inc., a member of the executive board of the Fairfield County Council, Boy Scouts of America, and a trustee of the Fairfield Public Library.

Leo B. Moore, professor of industrial management, was honored on June 2, 1982 at the M.I.T. Quarter Century Club's annual retirement dinner. Leo served 36 years at the Institute.—**Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

38 45th Reunion

Plans for the Reunion are well under way. Chairman **Don Severance** held a meeting of the Reunion Committee at the Faculty Club last December and announced that the preliminary reservations were greater than ever before. If you haven't signed up yet, the date is June 9; Boston Pops, Technology Day, and then a fair-weather weekend at the Wianno Club in Osterville on old Cape Cod.

I recently got a postcard from Jean and **Ed Hadley**, who have been wandering around New Zealand. . . . Sandy and I recently had dinner with Roberta and **Horace Homer**. Now that Horace has retired, he decided it was time to learn about the computer—so he bought one and is taking adult education classes to learn how to use it. . . . Ellen and **Russ Coile** moved to Pacific Grove, Calif., where Russ is working for Planning Research Corp.'s Scientific Services Support Co. at Fort Ord. . . . **Johnny Craig** threw in the sponge after 43 years with the Bell System, and, needing something to do, became a Selectman in Woodbridge, Conn.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Gordon Pope was recently in California and visited **Al Thackara** at Emerald Bay, Laguna Beach. When Gordon drove 70 miles southward, we took the opportunity to share with Billie and **George Cremer** the pleasure of Gordon's company and humorous recounting of many adventures. In between other recent events, Gordon wedged in the sale of the majority interest in his Puerto Rico company, loss of about 40 pounds, and news that **Dick Cella** is dividing his time these days between operating his New York restaurant and making transoceanic voyages in his sailboat. Would you believe that, at age 61, Gordon made a parachute jump from an airplane?

Elaine and **Sam Sensiper** have been living near the Pacific in Los Angeles for about 30 years in a home they expanded to accomodate Sam's business in microwave specialties. Hilda and I visited the Sensipers during October when the Space Shuttle put two communications satellites in orbit. Sam contributed to the design of some microwave elements on the satellites and had some interesting stories to tell. And on the down-to-earth side of microwave technology, Sam contributed to, or designed, an antenna used in retail stores to discourage shoplifters. Who would have thought at Freshman Camp in 1935 that one of our classmates would someday generate fame and revenues from such widely-divergent applications of the science we were then about to explore via 8.01 through 8.04?

Speaking of exploring, Aletta and **Bob Touzalin** have been doing that in England, Scotland, and The Netherlands. We expect them in California early in 1983 after which we'll relay details of their adventures. . . . **Don Waterman** retired as trust officer of a Bridgeport bank. Probably Don has some in-depth experiences in estate planning and gifting. Were some classmates to feel the urge to make further significant contributions to M.I.T. which "tooled" us all up and made it possible for us to earn the extra good things in life, Don might be in a good position to help with tax optimizing and other planning.

In the department of "It's a small world," Hilda recently phoned a nearby little theater to ask about an upcoming play. The lady she spoke with turned out to be the wife of **Tom Blakistone**, who is directing that play. The Blakistones live at Del Mar, about 15 miles north of us and we hope to see them before curtain time.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

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There is no shortage of news to report this time—thanks to all.. . . **Hy Freedman** writes that he retired from the practice of dentistry, after having surgery for cancer. This prevented him, and his wife Adeline, from spending the summer aboard their 32-foot sloop. They have retired to a house built in 1804 in the historic village of Wickford, R.I., which is just across Naragansett Bay from Newport. He is now a volunteer ambulance driver and a trained emergency medical technician. Five grandchildren to date. . . . **Dave "Beano" Goodman** writes from Hanover, Ind., to let us know that he is still working and is still an avid tennis player. "Father Time has quieted most of my vices, but life is still fun." . . . **Ted Gundlach** has given up his Michigan address and now has a condo in Venice, Fla. and a fishing camp in the Blue Ridge mountains. He has two new grandchildren. . . . **Fred Henrickson** is still enjoying his work as a consultant because of its variety. . . . **Ed J. Kingsbury** has been elected president of the Wellesley Historical Society. Since his retirement from E. F. Hutton Co. in 1979, he has spent much time in writing and producing slide/tape programs and shows on the history of M.I.T., Wellesley College, Dana Hall School, and the town of Wellesley, Mass.

J.T. "Dale" Madill writes that he recently retired as vice-president of power operations, purchasing, engineering and construction for Alcan Smelters and Chemicals, Ltd., Montreal, Canada, but will be doing private consulting work. His new address is 164 Seigniory Ave., Apt. 1002, Point-Claire, Quebec, H9R 1K1, Canada. . . . **Frank Penn**, who retired in 1981, is currently involved in Connecticut state senate politics, as treasurer for the election campaign. (Hope you were successful, Frank.)

Arnie Wight recently received credit for his work as chairman of the Science and Technology Committee and member of the Joint Legislative Committee on Radioactive Waste Management in New Hampshire. Arnie says, "Using volunteer experts we were able to formulate an energy policy. Now one of the real challenges is to see that the plan is followed."

We come to the sad portion of this news article—reporting deaths of our former classmates. . . . **Paul K. Bunke** died on September 13, 1982, in Woburn, Mass. Paul had retired from Caltex and had resided in Rye, N.H. since 1970. . . . **David M. Johnstone**, had a heart attack on October 23, 1982, in Stonington, Conn. Having been active in state politics for many years, at the time of his death he was running for the state house of representatives. Dave served as an officer in the U.S. Navy during World War II. He was a long-time resident of Stonington and a great sailor. . . . **Mrs. Edward J. Kinsbury (Edith M. Cameron)** died on April 18, 1982 in Keene, N.H. Edith, a long time resident of Wellesley, Mass., had been very active in the Wellesley Historical Society. Doll houses were her specialty; she created the Wellesley Centennial Doll House in 1981. . . . A brief note from Mrs. Pew indicated that **George T. Pew** passed away on August 2, 1982. George had operated his own business, George T. Pew Enterprises, in Haverford, Pa., for many years.

HELP! HELP! The Class of '40 has lost track of 41 of its members. Can you tell us anything about them? If so, please send any info to your class secretary. They are: **R. R. De Arellano Y Cano, Martin L.E. Bahner, Alfred P. Barton, Joseph Blackman, Milton H. Borg, Jennings Braun, John R. Diver, Andrew J. DuFourde, Richard H. Goodell, Alfred J. Green, Edward R. Harris, Harold R. Hobkirk, William Z. H. Hwa, Bunlua Jubandhu, Dr. George J. Lorant, Ian M. MacLeod, Gerald J. McCaul, William C. McDonald, George Miller, George Mounce, Borge P.E. Nissen, Augustus P. Norton, Jr., Harold B. Palmer, Robert A. Parent, Peter G. Park, James H. Reid II, Wilbur L. Roach, Budd R. Robb, Clifford L. Sackett, Dr. Hilmi F. Sagoci, Charles F. Sargent, William J. Schnorr, Prof. Frank L. Sheldon, Lt. Col. Stanley C. Skeiber, R. Robert Snyder, William H. Stone, Kenneth Yaoyuan Sze, Robert M. Weiss, Lawrence E. Welch, Richard H. Wheeler, Jr.,** and **George Wirkowsky.—Donald E. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

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A nice note comes from **Carl McGinnis** who gives us a fast outline of his career. Carl got his Ph.D. in nuclear physics at the University of California at Berkley and then was a physicist with the National Research Council in Washington, D.C. for about 10 years. He became an executive with Southwestern Cement in Los Angeles where he served

until 1970. Carl then retired, found retirement did not suit him, went to University of Southern California Law School and graduated in 1980. He was admitted to the California Bar last winter and then entered computer school. Carl is now starting a couple of new careers. All of this while a lot of us are thinking about retirement!

One of the shortest reports on record has just come in from **Harry Davis** of Course XIII. I can quote it in its entirety as follows: "Retired." How's that for brevity!? Also a report (this one in caligraphy—very fancy indeed) from **Alex Smith** who was awarded two distinguished professorships by the University of Florida—one from the National Alumni Association and the other a distinguished service professorship. They were, respectively, in astronomy and in physics.

A note from Betty and **Jack Quinn** says all kinds of nice things about the 40th Reunion. The enclosure was a beautiful full-color brochure about the 1982 California Cup Race of the *Condor* vs. *The Kialoa*. These are apparently very large sailing vessels, 80 feet long and weighing around 80,000 pounds each. In any case, Jack is the public relations man for the race, and it is a very impressive looking promotion piece.

There's an interesting article which appeared in the *National Productivity Review* by Jerry Coe entitled, "Measuring the Success of R&D Innovations." Jerry is retiring as of January 1, 1983 and plans to do, perhaps in the following order, although I don't know: teaching, consulting, more sailing, and more skiing!

Received a copy of a letter from **Chug Kennedy** (also known as Elder Charles Kennedy Senior to his bishop) reporting on his and Petty's missionary trip to Columbia. The report to Bishop Moody ran four single-spaced pages, and it is really too bad that space limitations do not permit quoting it at some length. Suffice it to say that Chug spends a lot of time and a lot of effort in the missionary work he does in a very competent and sensitive way for his church.

Since this is being written in November, it is time to wish all and sundry a Merry Christmas and a very happy and healthy New Year. The news is scarce. How about a New Year's resolution to send me some of that commodity.—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

43 40th Reunion

I am once again indebted to **Dick Feingold** for a news item (an ex-secretary really understands the problems of this job): **Tom Dyer**'s consulting firm, Thomas K. Dyer, Inc., of Lexington, Mass., has been acquired by the architecture, engineering and planning firm of Howard Needles Tammen Bergendorf. Tom worked for a number of years for the Boston and Maine Railroad before starting his own transportation consulting firm in 1963. TKDI will operate as a division of HNTB, with Tom continuing as president and becoming an associate of the new parent company. The 25th Reunion Book recorded that Tom had a wife, Hilda, and five daughters. Dick did not report on the current number of grandchildren.

Our Class President, **Ken Warden**, recently led a time management seminar sponsored by the Chamber of Commerce of Greater Norwalk, Conn. Ken is president of Life Management Associates, Lexington, Mass., which has helped many businesses with the problems of human resources development and management growth.

From Crown Zellerbach in San Francisco comes the announcement that **C.G. (Jack) Hornor** retired at the end of 1982 as vice president and general manager of the Newsprint Division. Jack had a long career with Gaylord Container Corp. After Gaylord's merger with CZ in 1955, Jack moved up in the successor organization, arriving at his recent position of vice president in 1973. I hope that in retirement Jack will find the time to send some personal news to the class notes.

This is all the news I received. When you send in more, there will be a longer column.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Martha's Vineyard Weekend: A limited number of rooms have been reserved (until May 10) for the M.I.T. Class of 1944 for June 10-11, 1983. When making your reservations please note your class affiliation at The Kelley House, Martha's Vineyard, Edgartown, MA 02539, (617) 627-4394. Also, call the Woods Hole Martha's Vineyard and Nantucket Steamship Authority for ferry information and auto reservations at (617) 540-2022 or toll free at 1-800-352-7104. (You need advance auto reservations if you plan to take your car to the island.) **Norman Sebell** would be pleased to hear that you are joining us for this weekend. He can be reached at 46 Brentwood Dr., North Easton, MA 02356, (617) 238-6672.

Flap Facts: **Francis E. Courtney, Jr.** is a certified consulting meteorologist and has completed his 40th year in meteorology this year. His firm, Courtney Consultants, Inc., serves a wide spectrum of industrial clients. . . . **William C. Cooley** notes that after 13 years his company, Terraspace, Inc., is still active in rock excavation research, hydraulic mining design, foreign technology transfer, and publishing. . . . **Robert D. Arnold** pens that he is now a mathematical statistician at the National Highway Traffic Safety Administration. . . . **Lamar Field** writes that he is still percolating along as a professor of chemistry at Vanderbilt. He teaches introductory organic chemistry, medicinal chemistry, and an occasional special topics graduate course. His research group is working on carcinogenic compounds, anticancer agents, antiradiation drugs, and metabolism of some toxic compounds, all tied to long-term studies on onganosulfur compounds.

Condolences: Through the M.I.T. Records Office we learned of the death on September 18 (1982) of **Robert L. Hunter**, chairman of the board of Hunter Corp., Hammond, Ind., and whose mailing address was Box 1289, Rancho Santa Fe, CA 92067. Our sympathies to his wife Elaine and his family.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

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Dave Clare, president of Johnson & Johnson (whom you certainly saw on the tube during the Tylenol activity), was elected a life member of the M.I.T. Corporation last June. Dave has been a member of the Corporation since 1977. A 1976 recipient of the Corporate Leadership Award, he is chairman of the Corporation Visiting Committee for the Department of Biology and a member of the Corporate Development Committee. . . . In late August, **James R. Hoaglund** was named president and director of McQuay-Perfex, Inc., a Minneapolis-based manufacturer of industrial and commercial heat transfer products. Two and one-half months later Jim was elected chairman and chief executive officer.

Attendees at M.I.T. Night at the Pops last June were **George Berman**, Dee and **Frank Gallagher**, Ann and **Bob Maglathlin**, the **Jim Pickels**, Nancy and **Charlie Hart**, Jan and **Charlie Patterson**, Louise and **Tom McNamara**, plus my wife Fran. Speaking of **George Berman**, the May 3, 1982, issue of *Business Week* had a lead article on George's company, Unitrode Corp., captioned "A Chip Maker Beat the Slump"! Unitrode was described as a button-down collar outfit—a real Yankee kind of firm. In 1981, the company netted $11 million on sales of $112 million, yet George plans to make Unitrode a $400-million operation by 1987—and we know it can be done.

Nina Phelps Strnad and Tracy Nicholas Putnam, both Harvard graduates, were married in Shaker Heights, Ohio, early in October. Yes, Nina's father is our J.J.—**James J. Strnad**, chief executive officer of Lempco Industries, a manufacturer of die sets and automotive parts founded by J.J.'s father. . . . **Jim Barrabee**, who was with International Harvester for years, is now with Brillion Iron Works in Brillion, Wisc., as manager of quality assurance. . . . **John Morrison** recently established a firm, Associates for the Transfer of Technology, which provides consulting and neutral third-party services for improving the flow of technology between companies, universities - and countries. . . . **Don Lovell**, although semi-retired, continues active in optics and computer simulations. . . . A Sigma Nu newsletter indicates that **Pete Schwab** passed away in September, 1972—some 10 years ago. Most of you will remember Pete as a *VooDoo* editor in 1944.

The May/June 1982 Class of '46 Notes indicated that one could get a copy of F. Curties Canfield's 35th Reunion speech by requesting it from Jim Goldstein—and I did just that. Should any of you want a copy, please let me know, as it is a masterpiece—and to whet your appetite, let me quote one brief paragraph: ". . . I see very few signs of the five 'B's that mark the onset of middle age: Balding, Bifocals, Bridges, Bulges, and Bunions. Maybe that's because of those predawn workouts on the gridiron, under the tender supervision of Gintoff, Mulrey, Reese and company . . ."

Two recent telephone conversations: **V.K. Butler**, from Santa Cruz, Calif., one Sunday morning, reported that he was off to the christening of his first grandchild. . . . **Jim Brayton** indicated that he had just returned from taking his 26-ft./10-ft. beam open fishing boat from Westport, Mass., to Cape Canaveral, Fla.—16 knots average, two weeks, 400 gallons of fuel. Jim also reported his and Ellen's trip to Scotland, Yorkshire, and London in September.—**Clinton H. Springer**, Secretary, Box 288, New Castle, NH 03854

46

In the January column I casually tossed out a comment about **John Maynard**. We got a note from him explaining his whereabouts: "Janet and I now live at PGA National, Palm Beach Gardens, Fla. After 35 years with Honeywell as engineer and manager, I am now a regional sales representative setting up distributors for powerline carrier communications systems. Play as much golf as I can get away with, and Jan plays often. We have five grandchildren, ages 4-11, living in Pennsylvania and Massachusetts."

And then another nice note from **Seward Kennedy**, (regrettably a Course II type—jus' kiddin'), telling us he "came back to London" in 1973 to work for Texas Eastern which has an interest in North Sea oil production. And after 15 bachelor years he's remarried (last June) to Tammis Schoenig, a young, fifth-generation Texan. Says he still loves London, and traveling. Sounds teddibly romantic, what?

While we weren't looking, **Sam Meerbaum**, another Course II exile, got his Ph.D. in bioengineering and is now senior research scientist at Cedars-Sinai Medical Center in Los Angeles. He says, "Recently I've been active in major cardiovascular research aimed at understanding and treating heart disease. At the Cedar-Sinai Medical Center, we are developing new diagnostic techniques, including echocardiography, digital angiography, and nuclear imaging. We are also providing new nonsurgical approaches to the treatment of evolving myocardial infarction following thrombotic occlusion of coronary arteries. We hope that this research will lead to further decrease in the unacceptably high incidence of heart attacks. (Did you follow all this, **Russ Dostal**?) Anyone for aerobics and wheat germ???

A reminder sent us from "Chatsie" (Mrs. **Bill Schield**), wants us to know that **Ken Davis** is alive and well in New Yawk City and is president of Davis Turner and Co. Inc., declaring his ad-

dress as 2 5th Ave., No. 80, New York, NY 10011. I mean like right downtown, huh, Ken? Mebbe we'll all drop in sometime . . .

And while I'm thinking about it, I just wanted to say "hi" to **Bill Scheller**, good 'ol roomie type, roller skater, and horseman from Long Island (originally), who's been toiling at NAS, Pensacola these many years. Give us a jingle, Willy!—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

48 35th Reunion

Don Noble is our 35th Reunion chairman. The campus part of the reunion begins Thursday, June 9, with a buffet followed by an evening with the Boston Pops. Friday morning a program will be presented in Kresge auditorium. On Friday and Saturday nights June 10 and 11 our class has reserved space at the Chatham Bars Inn.

At the first meeting of the reunion committee **Sonny Monosson** accepted our unanimous nomination to be chairman of the publicity committee with the help of **Malcom Reed** and **Bob Sandman**. **Leon LaFreniere** is responsible for the program on Thursday with the help of **Herb Lipson** and **Malcolm Reed**. **Jim Manson** will take care of the Friday program and **Milton Slade**, Saturday. **Dave Finnegan** will get the souvenirs, **George Clifford** will coordinate registration helped by **Al Seville** in Cambridge and by your secretary at the Chatham Bars Inn. **Stan Abkowitz** is contacting the hotel to assure that we get competitive room rates. **Herb Kurinsky** is going to contact classmates in Florida for a warm-up cocktail party. **Herb Lipson** will arrange the sports program on Saturday—don't forget **Dave Finnegan**'s crochet challenge cup. Also at the meeting was **Graham Sterling**, class president, and **Joe Martori**, associate secretary of the Alumni Association and an honorary member of our class.

I missed the warm-up cocktail party at Eleanor and **Harry Ottobrini**'s house, but Nancy Noble said it continued the successful trend of the earlier parties.

In September at the Alumni Officers' Conference Bill Hecht, executive vice-president of the Alumni Association, announced that I was a recipient of the Harold E. Lobdell, '17, Distinguished Service Award, an award second only to the Bronze Beaver. The award recognized me for my service to M.I.T. as secretary of our class, co-chairman of our 25th Reunion, and member of five reunion committees. Also, I organized three annual Rhode Island telethons for the Alumni Fund, several Class of '48 telethons, was regional chairman for several years, and was co-chairman of the Second Century Fund in Rhode Island. As a result of a letter I wrote to classmates in 1949, many purchased life insurance and then assigned the dividends until 1973 to M.I.T. The Class of '48 Endowment Fund resulted from this effort and currently exceeds $16,000.

In Rhode Island I was an officer and director of the M.I.T. Club for ten years and arranged faculty speakers for many alumni meetings. As a member of the Alumni Council I served on the personnel committee and on the committee to plan Technology Day in 1969-71. I organized the entire Alumni Day Program in 1970. That day there was an alumni lock-in by radical students, and I helped disband the group. As a member of the Long-Range Planning Committee I wrote several reports describing the results of surveys to identify which programs interested alumni.

My award was announced in San Francisco while **Denny McNear** presided over the meeting, however it will be presented during our 35th Reunion at the Saturday night banquet. Please come and share my happiness.

Phil Macht, still living in Baltimore, recently wrote a comedy, *Big Mac*, in which one character is a computer, scheduled to be performed by a Baltimore drama group. . . . **Dan Levin** has left the Corps of Engineers after ten years to accept a position with the Army Natick (Mass.) labs as a project engineer in the Aero-Mechanical Laboratory. One of Dan's projects involves using a parachute to extract heavy earth-moving equipment from an airplane and to drop the equipment to the ground without having the plane land. The unloading operation occurs while the plane is flying close to the ground. Dan finds life with his two little grandchildren who live nearby to be really fun and games.

Gardner Rogers spent 1970-77 in Australia where he managed a subsidiary company of Fluor. He and his family returned to the Philadelphia area, and he accepted the position of director of budgets, planning and control in the mechanical department of Conrail. On January 1, 1981 he assumed the position of director of corporate planning. Their older daughter, Ann, is in research with Cutter Labs in Berkeley, Calif. (microbiology and biochemistry) and plans to secure an M.D. starting in 1983. Their younger daughter, Barbara, is pursuing a Ph.D. program in religion and culture at Duke University.

Ed Kosower is professor of chemistry at Tel Aviv University and adjunct professor of chemistry at State University of New York, Stony Brook. Ed writes, "It is a pleasure for me to say that I will be visiting professor of chemistry at M.I.T. in the spring, 1983 to teach 5.54, physical organic chemistry." Ed and I were good friends in the dorms; I am looking forward to visiting with him next spring.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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35th Reunion news: We have tentative bookings at two resorts—the Wychmere Club, Harwichport, Cape Cod, and the Hotel Inverurie, Bermuda. Which do you want? Class president **Harry Lambe** and reunion chairmen Pam and **Mickey Ligor** have to know quickly. That's why a mailing is to be sent to all classmates asking if you'll probably come and which location you want. The committee has been working hard, and Pam Ligor has been doing a lot of communicating. There are lots of options and a chance of a good deal or two. **Harry Lambe** reports that the committee is large, active, and growing. It now consists of him and wife Jean, Pam and **Mickey Ligor**, Dot and **Jim Christopher**, Sonya and **Frank Hulswit**, Roz and **Stan Margolin**, Eunice and **Joe Schnieder**, and Doris and **Mal Kurth**, who drive from Pittsfield to attend meetings. **Mal Kurth** is the same guy who sat on his balcony, drinking a martini and directing the Bahamas Fire Department while they extinguished a fire on the floor below him, during one of our earlier post-reunion trips. Mal is also the same guy who hooked our 1949 Beaver Rug, that all will have an opportunity to see in either Cape Cod or *Bermuda* (please note secretary's bias). . . . **Harry Lambe** saw Belve and **Charlie Walker** in Houston. Charlie is with C. F. Braun, heading their marketing and sales of engineering and construction. Charlie said to count on his attendance at the 35th.

Sad tidings and good news from **Ken Prytherch**: his wife Sofia passed away in 1981. However, last November Ken married Sofia's sister Evelyn. Ken says, "I am, indeed, a fortunate man." Congratulations, Ken! . . . I received a fascinating letter from **Earl Eames** describing recent life in Egypt—living in an apartment on an island in the middle of the Nile, taking a weekend trip to see Jerusalem, trips up the Nile—and many impressions of Egyptian life and culture. Earl and Anyes have been having a marvelous time—hope they can make our 35th and tell us about it.

Frank Hulswit, our class vice-president and reunion committeeman, sends us some personal data. In thirty years with Arthur D. Little Co., he has gone from modeling operating systems (operations research) to helping organizations change (organization development). Four years ago he put both parts together and started working with some very powerful approaches to modeling effective personal/interpersonal behavior and applying it to new kinds of training and other organizational approaches designed to make people more effective. As a result, Frank was presented a Presidential Award by Arthur D. Little. Frank and Sonya are also planning ahead, and have bought a trailer and some land near Fort Myers, Fla. But we will, of course, see them at the 35th. . . . **Arthur Morrow** has been with the Harris Corp./PRD Electronics Division for the past 15 years. Arthur was program manager-director for the initial deliveries to the Navy of the VAST System for carrier aircraft support. He is now vice-president for systems management and logistics. . . . **Jacob Marinsky** reports that he is a professor of chemistry at SUNYAB.

Tom Lamphier says he has retired, but reports that he has been working as an internal consultant to the transportation group at Arthur D. Little, joined the Board of Directors of Arctic Enterprises, was elected to the Board of Trustees of the James Jerome Hill Reference Library, and is still chairman of the board of the Lake Superior Transportation Museum in Duluth—"One of the finest railway museums in the U.S.A., Duluth needs all the help it can get." . . . **Albert Humphrey**, head of team action management for Smith Steelwork in Whitchurch Shropshire, saved 189 jobs by the use of this management system, which increased productivity and profits. . . . **David Bailey** has been appointed chief engineer of the transportation programs at MITRE's Metrek Division in McLean, Va. Prior to joining MITRE in 1959, Dave was employed at Lincoln Labs and Bell Aircraft.

A good bunch of news this month. Please keep sending it in. See you at the 35th!—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017

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Walter Hylander retired from the U.S. Army in 1974 and now owns and operates Rosswood Plantation, an antebellum tourist attraction and Christmas tree farm near Natchez, Miss. Walt is also civil group supervisor with Bechtel Corp. at Grand Gulf nuclear plant. . . . **John H. Bickford** is presently vice-president of Raymond Engineering, Inc., in Middletown, Conn., in charge of a division which sells mechanical, hydraulic and ultrasonic equipment for critical bolting jobs. **Anne Bickford** works for architects Russell, Gibson, Van Dohlen, in Farmington and is currently involved in what will be the tallest building in Hartford. John and Anne recently had a one-family art show: paintings, drawings, photos, glass—their work and that of their three children.

In July 1982, Goodwill Industries of America announced the election of **Harry Tecklenburg** to the office of president of GIA's Board of Directors. Goodwill Industries is an international organization providing vocational rehabilitation services to disabled people. It is the largest organization of its kind in the world. Harry was first elected to GIA's Board in 1978 and served as vice-chairman until his recent election to the office of president. Harry lives in Cincinnati, Ohio, and is senior vice-president of the Procter and Gamble Co. . . . **Hubert L. Barnes** will return to M.I.T. as Crosby lecturer of the Department of Earth and Planetary Sciences for March-May.

The year 1982 was unique for **James C. McAllister** and his wife, Hilde, in that both of their sons moved with their wives from the hometown—one to the east (New York State) and one to the West (Oregon)—leaving the old home sort of empty. Jim is still employed by McDonnell-Douglas, in charge of corporate telecommunications. He has been there since 1950. . . . **J. Haroldo R. Falcao** informs us that he has his own company, which exports Brazilian products to the U.S.A., E.E.C., Northern Africa, Middle East and Far East. The products follow a very diversified pattern: carbon steel products, specialty steels, tin metal, agricultural commodities (sugar, coffee, cocoa), and fer-

tilizers. He has connections in Brazilian government and most industrial and agricultural centers of Brazil. He has been married for 28 years, which has produced six children and two baby granddaughters. One of his daughters and son-in-law have been taking graduate work in math and economics at M.I.T. since the fall of 1981.

We were saddened to hear of the death of **Charles S. Tallman**, who passed away on July 18, 1982. Charles was living in Santa Barbara, Calif.—**John T. McKenna**, Secretary, 1 Emerson Pl., Apt. 11H, Boston, MA 02114

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Frederick D. Ezekiel says "I recently started marketing my new patented magnetic-liquid shaft seal for protecting computer memory discs. This is done under our Servoflo Corp., in which my wife, Bessie, is the vice-president." . . . **Paul R. Rotherly, Jr.**, sends this note: "Remarried two years ago—instantly acquired two additional delightful children and one wife. Manager and co-owner of brass and bronze recycling (refining) company; currently president of our church. Life varied, full and satisfying." . . . **Bernando J. Garza-Sada**, chairman and chief executive officer of First International Bancshares, Inc., Dallas, was elected director of Grupo Industrial Alfa S.A., a bank holding company. . . . **Robert S. Woolworth** is currently in charge of the New Jersey office of Converse/Ward/Davis/Dixon, Geotechnical Engineers. He has sent two daughters to M.I.T., and his eldest is at Stanford grad school on fellowship. . . . **George A. Shumway** has published (by his own company) a large two-volume book, *Rifles of Colonial America*, which follows *Charette at York, Pa., April 1970* and *Conestoga Wagon 1750-1850*. . . . **Herbert H. Woodson** is director of the Center for Energy Studies at the University of Texas, Austin.

Walter E. (Mike) Johnson is manager of metals and ceramics, materials and processes at General Electric Co., Louisville, Ky., where he has been employed since 1960, following a career with Reynolds Metals and U.S. Naval Ordnance. He is reponsible for selecting metals and metalworking processes for use in General Electric's major appliance design and manufacture. . . . **Evan Evans** was named to the new post of vice president, international, of Western Crude Oil, Inc., a marketer and transporter of crude oil, natural gas liquids, and petroleum products. Evan, formerly a director and vice president of United Refining Co., was also named president of Wesco International, Inc., and managing director of Easco S.A., both subsidiaries of Western Crude Oil. . . . **Don Brown** is designing aluminum manufactured buildings for export to Israel, Algeria, Trinidad and Korea. On a recent business trip to China he visited Canton, Xiaohing, Guilin (Kweilin) and Hong Kong. On the return trip he saw Jeanne and **Gordon Potter** in Honolulu continuing their pleasant life in paradise.

Merton C. Flemings, respected internationally for pioneering research that has led to development of new casting and crystal-growing methods, has been named Toyota professor of materials processing at M.I.T. Merton is director of M.I.T.'s Center for Materials Processing, an interdisciplinary unit within the School of Engineering. Professor Flemings has been a key figure at M.I.T. in casting research and teaching of related materials engineering subjects. He pioneered the development of solidification science underlying industrial casting and crystal growing processes. . . . **David V. Ragone**, president of Case Western Reserve University was elected a director of the B.F. Goodrich Co. . . . **Howard D. Chapman** is located in Des Plaines, Ill., where he is a principal in United Executives Ltd., a management consulting firm doing executive search work at both the national and international level. . . . **James H. Ballou** had two cataract operations in 1980 and has given up his practice after 26 years on the North Shore and relocated at 1023 Casuarina Rd., Del Ray Beach, Fl., where he is associated with Kenneth Hirsch Associates, Architects. . . . **Charles H. Carpenter** writes, "I am still at American Science and Engineering, but have shifted my activities from international solar polar mission to load management." . . . **Gerald Doherty** died in November 1981, following a long career in Scituate, where he designed many South Shore schools and a variety of other projects.—**Gregor J. Gentleman**, Secretary, 818 Southwest Ninth St., Des Moines, IA 50309

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Class secretarial duties tend to set me thumbing through our edition of *Technique* to refresh my memory of some classmates. Recently I noticed the list of members of Osiris, M.I.T.'s secret society. If you have never heard of it, that merely shows how well the secret has been kept. Judging from my acquaintances among the names there, those who selected them could have been looking for likeable people who had contributed a lot to the M.I.T. community, or for futurewinners in life's struggle. If it was the latter, although there are many among us who have done pretty well without ever having learned the secret handshake, one can only admire the prescience of those who included **Joseph F. Alibrandi** in the group. As a recent press release from UCLA reminds me, his achievement and potential have been continually recognized ever since.

In addition to serving as chief executive officer of Whittaker Corp., a conglomerate specializing in health care, Joe recently completed six years on the board of the Federal Reserve's 12th District, the last two years as chairman. He is currently a director of a large California bank, a New York think tank, and the U.S. Chamber of Commerce. He is chairman of the U.S. Chamber's International Policy Committee, and co-chairman of President Reagan's Private Sector Task Force, formed to survey cost control in the federal government. At UCLA he is chairman of the Business Advisory Council, a director of the UCLA International Student Center, and he belongs to a couple of organizations in the Graduate School of Management. The occasion for the press release was his election to the board of trustees of the UCLA Foundation, a fund-raising group. No information was included on what he does in his spare time.

Aline S. Szczesniak, Sc.D '52, has been elected a fellow of the Institute of Food Technologists, and also named Scientist of the Year by its New York section. She is an expert in food texture and has worked for General Foods since getting her doctorate.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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We raise a glass to the lads of Delta Kappa Epsilon who were responsible for M.I.T.'s first victory in the annual Harvard-Yale football game. The clever DEKEs planted a Jack-in-the-box on the 46-yard line just in front of the Harvard bench. In the midst of an exciting game (which Harvard would otherwise have been destined to win) out popped a large weather-type balloon and pump. The crowd watched in deathly silence as the balloon, emblazoned with "M.I.T." all over, grew and grew till it finally burst. Hooray for M.I.T. and its loyal sons! And thanks to Derek Bok, president of fair Harvard, who acknowledged with gracious aplomb the magnificence of the feat.

Congratulations to **Thomas Bastis**, who was recently named president of Ameron HC&D in Honolulu. The firm is a division of Ameron Inc., a multi-national construction materials and contracting organization. Tom has been an Ameron executive in Hawaii for the last ten years and is very active in community affairs on the isle of Maui. He is also incoming chairman of the Cement and Concrete Products Industry of Hawaii.

We would appreciate hearing the latest news from members of the class. Please drop a line to one of us today. Thanks.—Secretaries: **William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

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Congratulations to three classmates. United Nuclear Corp. Naval Products has promoted **George Waugh** to executive vice-president of operations. George joined UNC in 1957 as an engineer, and he advanced through various management positions in production, engineering, and quality control. He had been vice-president of quality control since 1979. UNC Naval Products is a precision machining and assembly manufacturer and is a unit of UNC Resources in Falls Church, VA. . . . **Scotty B. Patrick** has become administrative vice-president, technical at Ashland Chemical Co. He will be responsible for Venture Research Engineering, Licensing and Specialty Fuels, and Melamine Chemical, Inc., a joint venture company. Ashland Chemical Co., a division of Ashland Oil, Inc., is a major manufacturer and marketer of chemicals, chemical specialties, and resins worldwide. . . . **Edward B. Roberts**, David Sarnoff Professor of Management of Technology at M.I.T. Sloan School, has written an interesting article on how large technology producers can increase the payoffs from licensing. For those interested, the article appeared in the September 1981 issue of *Les Nouvelles* (Journal of the Licensing Executives Society), and was entitled "Is Licensing An Effective Alternative?"

I certainly would appreciate notes, letters, and even phone calls with information for this column. We all love to read the news, so how about a tidbit or two from your exciting or not so exciting lives. Somebody must be doing something out there!—**Vivian Warren**, Secretary, 156 Northrop Rd., Woodbridge, CT 06525

58 25th Reunion

Reunion plans are forging ahead. Lots of activities are planned including plenty of time to swap stories with your classmates. If you haven't already done so, please send along your preliminary registration and class dues, which are used to defray the costs of mailings to the entire class. Based on early returns, we project that our 25th Reunion will be a big winner!

Les Dirks recently joined the Raytheon Co. in Lexington as a vice-president. Previously, Les had served for many years with the Central Intelligence Agency as deputy director of science and research. . . . United Technologies has named **John Lovkay** to the position of executive vice-president of the Hamilton Standard Division. He will have responsibility for directing the Division's aerospace and electronics business units. John joined the company as a development engineer and then became manager of electronic systems in 1973 and vice-president in 1975. Since 1978 he has been senior vice-president of the electronics business unit. . . . The University of California, Davis School of Medicine has appointed **Michael Miller** as professor and chairman of the Department of Pediatrics. Since 1976, he had been research professor of pediatric immunology at UCLA and chief of the Division of Immunology and Hematology/Oncology at the Harbor-UCLA Medical Center in Torrance. He has received wide recognition for his work in pediatric immunology in the area of immune deficiencies, host defenses and recurrent infections of the newborn. He received his M.D. from the Downstate Medical Center of the State University of New York and did his postgraduate training at the University of Minnesota, Yale, and the Children's Hospital of the University of Pennsylvania.

In Washington, **Lawrence Coryell** has been

named program manager, Small Business Innovation Research Program at the National Science Foundation. . . . **Francisco J. San Miguel** was elected a vice-president of McDermott Marine Construction and a general manager with responsibility for the Morgan City, Louisiana and Gulfport, Miss. shipyards.

In Phoenix, **George Schade** is serving as chairman of the Arizona Section of the American College of Obstetricians and Gynecologists. He is in private practice and is affiliated with several area hospitals including Phoenix Baptist, John C. Lincoln, St. Joseph's, and Maricopa County General, where he is a clinical instructor in gynecology. He is a graduate of the University of Pittsburgh School of Medicine.

An alumni dinner at Nu Delta (previously a chapter of Phi Mu Delta) brought together 60 alumni, their wives, and friends. Attending were five Class of '58 members: Mary and **Sars McNulty**, Beth and **Al Russell**, Mary and **Bernd Gunther**, Nancy and **Mike Brose**, and Kathie and **Glen Strehle**. The occasion proved to be a delightful warm-up for the reunion, and everyone in this group plans to attend in June. . . . We'll see you all there! Make your plans now and include some of that hard-earned vacation time to see a little bit of the New England area.—**Michael E. Brose**, Secretary, 59 Rutland Square, Boston, MA 02118

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At the outset, I would like to correct an error which appeared in the October 1982 notes *Review*. **Barry Altschul**'s wife Brenda was erroneously identified as Barbara. With apologies to Brenda, all our classmates are advised that she and Barry will be celebrating their tenth wedding anniversary this coming February.

Since 1955, I have constantly been amazed at the unending energy of **Allan Bufferd**. Al continues to amaze me with the number of different pies or plates that he can keep juggling. He has just become associate treasurer and recording secretary of the Institute, in which capacity he will be involved in formulating and implementing investment policy for Institute funds, while continuing his role as recording secretary and supervising the acknowledgment and recording of all gifts and grants to the Institute.

Bruce Blomstrom has accepted a position as senior vice-president for marketing, sales, and planning at Alpha Therapeutics in Los Angeles. The company is wholly owned by Green Cross Pharmaceutical Co. of Japan. Those wishing to write to Bruce can do so at Alpha at 5555 Valley Blvd., Los Angeles, CA 90032, (213) 225-2221 or (800) 421-0008.

Congratulations to **Elmer F. Delventhal** upon receiving his Ph.D. in mathematics education from the University of Connecticut in May 1982. His dissertation concerned the effects of mathematics tutoring on the attitude and achievement of college algebra students. . . . Congratulations are also extended to Dr. **Robert Oder** upon his election to the board of directors of Eriez Magnetics, Erie, Pa. and to **Ken Molloy** (Course VI-A) on his promotion to vice-president of Bowmar Instrument Corp.

With winter rapidly approaching, I invite all of you who are skiing enthusiasts to meet my wife Joan, me, and our numerous children and dogs at Killington, Vt. on weekends from time to time this winter. We have just purchased a condominium at Mountain Green, at the base of Killington Mt., where you will probably be able to find us on alternate weekends throughout the winter. We are also planning to be there during the Lincoln's birthday, Washington's birthday week. Our telephone number is (802) 422-3083.—**George L. Barnett**, Acting Secretary, 90 Broad St., New York, NY 10004, (212) 363-4600

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Nathaniel Florian was in the news last year as a member of the Southington, Conn., Board of Education. Nat, a co-partner of the American Standard Co., has been fighting to "bring God back into the schools," reports the *Meriden* (Conn.) *Record Journal*. He had proposed unsuccessfully that the school board include several references to God, and man's relation to God, in its educational goals. . . . **Phillip F. Frink, Jr.**, writes: "Two years ago, after 18 years of working for somebody else, I finally became my own boss. I purchased First Washington Corp., a small investment firm in Seattle, and I am having a most enjoyable experience. My wife, Noreen, and I have three children, 18, 16 and 12. A lot of my spare time is taken up being vice-president of Lakeside School (a private secondary school in Seattle), playing men's soccer, and coaching children's soccer." . . . **Richard J. Samaha** says, "I received my M.D. and Ph.D. in biochemistry from Boston University School of Medicine in 1966. Subsequently I did graduate training at Boston University, Memorial Hospital/Sloan-Kettering and National Cancer Institute, N.I.H. I am presently chief of hematology and oncology at Cardinal Cushing General Hospital, Brockton, Mass. My wife, Christine, is managing editor of Kent Publishing Co. in Boston, and we live in Hingham, Mass." . . . **Walter J. Tomlinson** tells us that since September 1981 he's been supervisor of the optical disk recording group at Bell Labs in Allentown, PA.

Ronald Agronin says, "So far this has been a hectic year—two visits to Europe and two to Asia. We are also moving into a new house next month. Our oldest son, Mike, really enjoys M.I.T. and it gives me an excuse to visit the school again." . . . Yes, some of our kids are now attending M.I.T., and **H. Larry Elman** claims there will be at least one more. Here's how he tells it: "News Flash from Long Island! Unless my wife Joan packs her off to Juilliard when I am not looking, a new member of the Tech class of '03 has just been born: announcing Elizabeth Nadine Elman. In 1976, Joan and I had David using 'prepared childbirth,' alias Lamaze. It was so enjoyable, we kept claiming we would go into mass production. And now, at age 6, the big-brother-to-be served as the youngest Lamaze coach on record. He had led Joan through all the exercises and breathing techniques flawlessly, and timed all the contractions as directed. I think he was cheated a little when we left him behind an hour later as we departed for the hospital. There were some complications and Lamaze had to give way to a Caesarean, but mother and daughter are both doing fine now. She was 7 lbs. 2 oz. and 21" long. As cute as her mother and smart like her M.I.T. forebears (not just me—Tech runs on Joan's side also). Joan played flute in the Hartford Symphony for a number of years, and she is now teaching privately. We've been here on Long Island for about two years—I am at Fairchild-Republic as the only aero in the avionics section. Still active in the Air Force Reserve, and still on the Bradley Air Museum Staff."

Gordon S. Mutchler writes, "I have just returned from the Swiss Institute for Nuclear Research, where I spent my sabbatical. My son Andrew, 13, learned fluent German. I did not. I have also just been promoted to full professor at Rice University. Lynne, '61 continues to work at the Texas Medical Center as a database manager." . . . **George P. Koo**, whose new address is 1819 Van Buren Cir., Mountain View, CA 94040, is currently an investment banker with Bear Stearns & Co., focusing on the Far East, particularly as related to trade with People's Republic of China. . . . **Samuel Gorovitz** says, "After nine years as philosophy department chairman at the University of Maryland, I'm taking a break from administration for a while to have more time for writing. MacMillan has just published my book, *Doctors' Dilemmas: Moral Conflict and Medical Care*, so I'm involved in the usual promotional activities like going on talk shows and writing Op-Ed pieces. I think it is the only philosophy book about clinical medicine written by an M.I.T. alumnus. The bookstores have no idea where to put it; my wife, Judie, saw one in Waldenbooks the other day under 'Diet'! Judie continues to practice clinical psychology in Washington and Gaithersburg; Heidi, 18, is a sophomore at Tufts; and Eric, 16, is having a grand time as a typical high school kid. We missed the 20th reunion because we were living in Oxford, England, at the time. We'll try to show up for the 25th."

Michael Modell, president of Modar, Inc., was granted a patent for a process which utilizes the unusual properties of water under supercritical conditions to oxidize organic materials and to generate usable energy. Dr. Modell began researching the properties of supercritical water while a professor of chemical engineering at M.I.T. He founded Modar, Inc., in May 1980 to develop a hazardous waste destruction system based on his research and to explore other viable opportunities for the commercial application of supercritical water. . . . **Stephen B. Russell** has joined ITT Courier Terminal Systems, Inc., in Tempe, Ariz., as executive engineer. Stephen has an extensive background in digital systems and communications, and is the first person to be named to this new position in the system planning and architecture group. . . . **Richard L. McDowell** is now dean of the School of Management at Suffolk University in Boston. . . . **Charles J. McCallum, Jr.**, is a coauthor of an article in the July-August 1982 issue of *Bell Laboratories Record*, "A 'Model' Way to Plan the Transatlantic Network." Charles is head of the operations research department at Bell Labs in West Long Branch, N.J.

George C. Harrison writes that he has been appointed a vice-president of Merrill Lynch Pierce Fenner and Smith, is working in the Seattle main office, and has "just lost 30 pounds on a diet!" . . . **Walter F. Crewson** is presently vice-president, engineering and engineering manager for Universal Voltronics Corp., Mt. Kisco, N.Y. . . . **Susan E. Schur**, president of Susan E. Schur Advertising, has been selected by the American Association for State and Local History to receive that society's 1982 Award of Merit in recognition of her contributions to conservation and local history. Her citation is based on her activities relating to *Technology and Conservation* (an international journal devoted to art, architectural, and archeological conservation, preservation, and restoration, which she publishes and edits) and to seminars she has organized in the areas of art conservation and building conservation. She has also been extensively involved in research, exhibit design, and lectures pertaining to the history of women at M.I.T. and the early history of women in science and technology in the United States. She has been head of the New England Conservation Association for the past two years and has participated in the designation and nomination of local historic landmarks. Susan had a showing of semi-abstract paintings on paper and board from September 27 to November 15, 1982 at the M.I.T. Museum. I hope some of you got to see it. Maybe she and our other class artists can provide an exhibit for the 25th Reunion. What say?

We have learned that **William A. Martin** died June 2, 1981. At the time he was living in Brookline, Mass. We also regret to report the death of **W. Russell Hamon**, 3494 Bathurst Court, Lexington, KY 40503 on August 5, 1982. We express our sympathy to the bereaved families.

By golly, this time we're caught up on the news. And the notes that have come in from the Alumni Fund seem to have become more numerous, newsy, and chatty—for which, thanks. May it be a good year for thee in '83! And tell us about it!—**Noel S. Bartlett**, Secretary, 15320 Edolyn Ave., Cleveland, OH 44111

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This month's column is nearly all faculty news. . . . **Steven J. Brams**, professor of politics at NYU, has written his fifth book, *Approval Voting*, co-authored with P.C. Fishburn of Bell Labs. Approval voting is an election reform that allows citizens to vote for as many candidates as they like in an election having more than two candidates. . . . **John Hermanson** has been promoted to professor of physics at Montana State University and received their campus-wide Sigma Xi Faculty Research Award. His research focuses on computational studies of solid surface magnetism. . . . **Erich P. Ippen**, professor of electrical engineering and computer science of M.I.T., has received two awards jointly with a researcher at Bell Labs for work in electrical measurements—the Edward Longstreth Medal awarded by the Franklin Institute, and the Morris E. Leeds Award from the IEEE. . . . **Peter M. Maas** writes from Strathclyde University that he is now the second-longest-serving applied physicist at the university, and that only 12 years were required to transform a young turk into the last bastion of the establishment. . . . **Theodore Sheskin** is an associate professor of industrial engineering at Cleveland State University. He joined the faculty in 1974. . . . **Stephen J. Warner** is now president of Merrill Lynch Venture Capital, Inc., which is managing a $60 million venture capital partnership. They are seeking early stage investments in promising high-tech companies.—**John Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63 20th Reunion

Because of the tremendous time lag between submission and publication, this column, unfortunately, is not a good vehicle for publicizing the details of our 20th Reunion. Hopefully by the time this appears in print you will have received a letter with some of the info about the reunion, including whom to send your reservations to. As of this writing (Thanksgiving), the reunion is scheduled to be held June 10-12 at the Wychemere Harbor Club in Harwichport on Cape Cod.

Some consideration is being given to having a Cambridge rendezvous point, with bus transportation to the Cape. That might be convenient for those of us coming in by plane, who will not have access to a car. Activities for the weekend would include cocktails on Friday evening, a beach picnic on Saturday followed by a dinner and dancing, and a Sunday brunch. Anyone with inputs for the reunion, particularly those willing to help with arrangements, may contact class president **Ira Blumenthal** at American BHF Corp., 21 Cummings Park, Woburn, MA 01801, (617) 938-1208. Remember to mark your calendars and convince a friend to attend.

Well, so much for news of the future. Let's get on with news of the past. **David Claypool** writes that he and Caly spent a month last year on a round-the-world trip. Stopovers in Sri Lanka, Thailand, Singapore, Hong Kong, and Moorea (Tahiti) gave an interesting perspective to Asia and French Polynesia. The Claypools are enjoying living in Belgium, and they don't look forward to leaving.

Another alumnus with an international flavor to his work, **Robert Porter**, reports that in February 1982 he became vice-president of Nippon Schlumberger. This is a new Schlumberger company setting up engineering and manufacturing in Japan to support Schlumberger's wireline activities. Robert says that he and his wife, Charlotte, are enjoying Tokyo and are meeting many M.I.T. alumni in Japan.

Michael Schaffer informs us that he has now been at General Atomic, working on magnetic fusion research for the past nine years. The last three and a half have been spent on the OHTE project, a "reversed field pinch with a helical field" experiment. Mike says that although this approach is still a long way behind the front running tokamaks, the old barriers to reversed field pinch performance have been falling at a tremendous rate, and his work is very exciting. . . . **Stephen Hester** is living in Raleigh, N.C. and working for Northern Telecom, Inc. in marketing and sales of digital switching machines. He is currently technical director, ATT/Bell Operating Company Sales. Stephen spends his outside hours backpacking and working with Junior Achievement.

Pat (Selby) Marzilli is still helping to edit the yearly book *Advances in Inorganic Biochemistry* with her husband Luigi (prof. of chemistry at Emory University), and Gunther Eichorn of NIH. Pat is also working part time in the Emory University Development Office. The Marzilli's three children, Alan, Veronica, and Alisa are now 6, 10, and 12 (as of last September). . . . **Gerald Childs** reports that last May he moved to a new position as manager, Business Environment Forecasting, and chief economist at Standard Oil of Ohio . . . I also discovered a classmate of ours working right here in my own back yard. **Len Ferrari** completed a Ph.D. in electrical engineering a few years back and has recently been working on signal processing applications in medical imaging systems in the medical school at the University of California, Irvine.

That's all for this month. Keep those cards and letters coming in (ha, ha). Remember June 10-12.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

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The outstanding letter in this month's mailbag comes from Miss Jessica Disman of Dusseldorf, W. Germany. It seems that **Steve Disman** is now a vice-president at Citibank and has been assigned to their German subsidiary since January 1982. The family—Steve, Donna and their two daughters, Jessica (13) and Julie (11)—are enjoying life in Germany, as the disadvantage of having to learn a new language is offset by the excitement of visiting many new places. Their new address is Inselstrasse 11, 4000 Dusseldorf 30, W. Germany.

Recently I have been working out at a health club and doing some running. On the night of November 10, I came home feeling really good about my condition: I had run a mile in 7:45 and felt great. I opened the mail and found a letter from **Paul Rudovsky** in which he described his recent entry in the New York Marathon. He ran the whole 26 miles at a 7:45 pace. I have been upstaged before in my life, but never by mail. Paul has moved to the Washington, D.C., area and has become the chief financial officer for Credit Card Service Corp. You can write to him at the company at 510 King St., Suite 500, Alexandria, VA 22314.

Peter Lobban has joined Sequoia-Turner, a start-up company making medical instruments, as a senior scientist. . . . **Donald Hansen** received his Ph.D. in clinical psychology in September 1982, and is presently working on his post-doctoral internship.

Carolyn, '69, and **Daniel Dedrick** have returned to Boston, where she is in radiology at Mass. General and he is at Brigham and Women's Hospital in anesthesia. They each hold Harvard Medical School appointments. . . . **Ed Seymour** is still working on special assignments for the American Institute of Aeronautics and Astronautics but has given up his full time position as corporate secretary of that group.

We attended the 60th Anniversary party of Nu Delta/Phi Mu Delta in November and met many people we had not seen in ages. Representing the class of '66 were **Dave Tweed**, Eileen and **Walt Shedd**, and Theresa and **Joe Shaffery**. The party was great and attendance was quite good—we met at least 15 couple from our era. . . . More than one person at the Nu Delta party asked just how desperate for class news I am. My wife replied that if we didn't get more letters we'd soon be running a column that said, "The Shaffery's son Joseph mowed the Shedd's lawn this month." If this isn't the kind of news you want to see, then please write.—**Joe Shaffery**, Secretary, 34 Hastings Dr., Fort Salonga, NY 11768

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The list of our class officers appearing in this column a few months ago failed to include **Joe Levangie** and **Bob Ferrara** who were elected vice-presidents at our reunion last June. . . . During the last three years **Bruce Jacobs** has published books on the War on Poverty and the housing of elderly Americans, the latter being the subject of a keynote address he gave at the White House Conference on Aging. Bruce is an associate professor of political science at the University of Rochester, where he teaches in the Public Policy Analysis Program. . . . Sarita and **Jim Dotson**'s second child, daughter Anjali, was born in 1982. Their son is 4 years old. . . . Mady and **Bob Dann** and their two children returned to Spain for a month last summer. Mady is in her final year at Temple Law School. Bob is working on a Ph.D. in neuroanatomy and continuing his work of the last few years studying glucose metabolism in the brain using positron emission tomography at the University of Pennsylvania. . . . **Chuck Greene** is producing a one-half-hour television series entitled, *Lorne Greene's New Wilderness*. . . . I am pleased to report that last October I became General Counsel of Ramtek Corp. in Santa Clara, Calif.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

68 15th Reunion

The mailbox has been nearly bare this month; even with a few items we judiciously saved from last month, we have a somewhat short report.

A small run on news items from people who have started their own companies: **Steve Finn** reports that he has left Codex, where he was director of research, to start a data communications company, Bytex Corp in Framingham, Mass., which manufactures electronic switching equipment. . . . **Ken Morse**'s consulting firm, KPM Enterprises, has entered its second year in the Boston area, providing marketing assistance to hi-tech start-ups seeking to launch new products and enter new markets. Ken has two daughters, Amy, 11, and Allison, 8, who enjoyed their introduction to sailing this past summer. If you are in the Wellesley/Boston area, Ken invites you to call. . . . **Jay Hellman** founded the Hellman Co., Inc. in August 1976. The firm has specialized in the development and leasing of commercial property in the Washington, D.C. area. Recently, they have been focusing on the impact of information processing and communication technology on how and where office buildings in the future should be built. . . . **Richard Ying**, who was a co-founder of Atex, Inc. nine years ago, has continued on as technical advisor since the acquisition of the company by Kodak. Atex has projects in pagination (developing complete newspaper or magazine pages on the computer system) and a videotext system.

In other news (as the newscasters would say), **Jeffery Stamen** has joined Management Decision Systems, Inc. in Waltham, Mass., as senior vice-president of the General Systems Division. . . . New England Electric has promoted **Jeffrey Tranen** to manager of coordination with the New England Power Pool (NEPOOL), a group of New England utilities which coordinates the planning and operation of generation and transmission plants of its members. . . . **Geoffrey Smith** has been hired as mathematics coordinator for the East Hartford school system. . . . **Shirley Jackson**, a physicist at Bell Laboratories, is among those selected in CIBA-GEIGY's Exceptional Black Scientists Poster Series.

Richard Odessey is living in New Orleans and

working as assistant professor at Louisiana State University Medical Center, teaching in the physiology department and doing research in muscle metabolism. He reports missing Boston. . . . **Razel Kallberg** is currently enjoying teaching physics, physical sciences, and mathematics at Berwick Academy in South Berwick, Maine. . . . **Duncan Teague** was elected vice-president and president-elect of the Southeastern Planetarium Association. He became president in January, and will serve on the Executive Council of the International Planetarium Society. Duncan is the director of the Memphis, Tenn. City Schools Planetarium. . . . **Tomas Mosquera** reports that he is managing director of two small business firms, respectively engaged in general consulting and in the design and manufacture of games for adults. . . . **Charles (Corky) Polay** is with DEC as manager of the Far East Manufacturing Group, running DEC manufacturing operations in Hong Kong, Taiwan, Singapore, and purchasing activities in Japan.

Kenneth Rosenberg writes that he and his wife, Shelley, have a son, Michael, who has recently celebrated his second birthday. Shelley is pursuing a doctorate at Temple University in psycho-educational processes, and Kenneth heads the real estate department in the law firm of Mesirov, Gelman, Jaffe, Cramer, and Jamieson in Philadelphia. . . . Finally, **Dave Ellis** reports that he had a second daughter, Dana Michelle, in June 1982. He is president of his local alumni chapter, the M.I.T. Club of Tampa Bay, and also enjoys interviewing prospective M.I.T. students as an educational counselor. He is currently practicing law with specialties in computer law, business and corporations, copyrights, trademarks, and trade secrets.

The mailbox is now empty. Drop us a line, or better still, plan to come to our reunion in June.—**Gail** and **Michael Marcus**, 8026 Cypress Grove Lane, Cabin John, MD 20818

69

Christmas is only a few weeks away. By the time you read this, I hope you have all had a good one. . . . **Jeffrey Reynolds** sent in a copy of a pamphlet filled with photographs he took expressing the impact of his third year as a medical student in Jackson Memorial Hospital in Miami, Fla. He received his M.D. and is now practicing across the country in Spokane, Wash. . . . **Ed Jernigan** has finished six years with Systems Design Engineering at the University of Waterloo, Ontario. Ed, his wife Kim, and daughters Amanda (4) and Carey (1) are building a super-insulated house on the Nith River where they expect to be staying indefinitely, although they may return to Boston for Ed's upcoming sabbatical.

Major **George C. Slusher** has one more year of teaching in the mechanical engineering department at the U.S. Naval Academy before being reassigned. His main outside interests are still horses and children. George is chief instructor at the local chapter of the United States Pony Clubs which teaches horsemanship, horse management, and a sense of teamwork and cooperation to young people. . . . Rosanne and **David C. Hill** moved back East from southern California three years ago, and David is now director of technology and business development for Allied's Fibers and Plastics Co. in Morristown, N.J. Their children, Lisa (8) and David (5), enjoy the seasons and raising vegetables on their three-and-one-half acre mini-farm.

That's all the news. Now for some missing class members: **Freddy Epstein, Fabrizio Franzi, Barry S. Gloger, Stanley M. Goldin, Herbert B. Goodman, Ray T. Hagstrom, Heikki I. Helava, Richard W. Hessdorfer, Daniel J. Hoban, Stephen C. Hopkins, Ali T. Jabali, Terrence J. Jach,** and **Alan D. Jassby**. If you know where any of them are, please let me or the Alumni Office know.—**Robert K. Wiener,** Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

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Stephen L. Hauser writes: "I am currently at Harvard Medical School and am doing basic research in the field of multiple sclerosis." . . . One question continues to haunt me: **Alan J. Brown**, where are you? . . . **Rob Pepper** is in Florida. He and his wife had a second child in June, a daughter named Katie. They live two blocks from the ocean and love the beach. . . . **Gerald E. Kardas** completed his M.S. in management at RPI's Hartford Graduate Center. He is with the Corporate Technology Department at Combustion Engineering, Inc. His wife of ten years, Jan Kleeman (Wellesley, '71) completed her Ph.D. at University of California-Berkeley and is now a professor at Brown University. . . . **Mark Oshin** is in his fifth year teaching math at Saddle River Day School, a small private college prep school. His activities include crossword puzzle contests.

Dwight A. Davis, now a budget analyst for Lockheed, would like to hear from the Bexley crowd. His address is 450 N. Mathilda, No. 9101, Sunnyvale, CA 94086. . . . **Etan Bourkoff** recently relocated to become an assistant professor of electrical engineering and computer science at the Johns Hopkins University. His research interests are in quantum electronics and nonlinear optics. . . . **Gordon E. Legge** was on the front page of the sports section of the *Minneapolis Tribune* for August 27, 1982 for his participation in the 1982 World Series of Beep Baseball. In the off season he is an associate professor in the Department of Psychology at the University of Minnesota. . . . **Barney C. Black** is still working for Newport News Shipbuilding but recently transferred out of industrial products marketing into submarine design. . . . In conclusion, I will ask the question: **Clifford Hagup Ananian**, where are you?—**R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

72

Thanksgiving time is barely here, and Christmas is still way around the corner as I write this note that you won't see until the chilly February wind and snow is upon us.

Bonny Kellermann and **Paul Levy** have done a great job since the reunion coming up with a class gift idea that captures the spirit of 1972. Hope everyone has had a chance by now to give to the M.I.T. Alumni Fund, Class of '72 Gift. Bonnie has been traveling around the U.S. visiting with educational counselors. I saw her at **Gail Thurmond**'s marriage to Richard Gorden, a Boston area lawyer. Saw a number of old friends there including **Bob Ebert**, **Dan Bloom**, Steve Tubbs, '74.

Robert E. Lindgren has been named a director as well as a consultant to A.S. Hansen, Inc. in Lake Bluff, Ill. . . . **Faruq Ahmad** has been working on telecommunications management in San Francisco since he left Intel. . . . **Richard P. Field** sent the brief note that he is at CV in Bedford, Mass. working on CAD/CAM and "Jargon: CAD/CAM it!!" . . . **Kenneth Holladay** moved to New Orleans last summer where he is now an assistant professor with the University of New Orleans mathematics department.

Allan T. Kirkpatrick, an assistant professor of Mechanical Engineering at Colorado State University is conducting research in natural convection. He and his wife Susan recently had a second child, Robert, who is the apple of his sister Anne's eye. . . . **David McDonald** is a computational linguistics and artificial intelligence professor at the University of Massachusetts at Amherst. He enjoys the area and its proximity to Cambridge.

Harlan E. Ives "finally finished a brutal residency" at Columbia-Presbyterian Medical Center in New York City and is now doing ion transport research as a fellow at the University of California in San Francisco which he finds appealing when he is not missing Boston. . . . **Carol Epstein** has moved to the Midwest which she finds a little less cutthroat than the East for practicing rheumatology. In May 1980 she married Michael Hoeflick, a lawyer and legal historian who is teaching at the University of Illinois. The Killington house is being sold so if anyone is interested in an eight-year season ticket at Killington, has Carol got a deal for you. . . . **Daniel Nadler** joined the group of, what else, Nadler, Pavlis, and Press in Sewickley, Pa. after finishing an ophthamology residency at New England Medical Center and a fellowship in anterior segment surgery in Miami. He also will be a surgical tutor on the staff of Pittsburgh Eye and Ear Infirmary.

Tom Klinkner moved to Anchorage after his 1975 graduation from law school where he also canoed, backpacked, and cross-country skied. He co-founded a small firm which represents school districts and municipalities. The past two years were spent at Stanford Business School where he met and married Deborah Godat (Wellesley, '77). Now he is back as senior staff attorney for the municipality of Anchorage. He hopes visiting M.I.T. friends will get in touch.

I'm sad to announce that **John Gaschnig** died of cancer last spring. This Thanksgiving he was featured on Nova's episode entitled *Cobalt Blues*. He had been working at the Stanford Research Institute.

Kathy Swartz resigned from the Economics Department at the University of Maryland and is now working in the health policy group at the Urban Institute in Washington D.C. She finds it a refreshing change. Kathy and husband, Frank Levy, '63, are enjoying very much their son, David, 4, and daughter, Marin Katherine Levy, born June 11, 1981.

I'm continuing to enjoy my career switch from practicing law to risk arbitrage. It has been an interesting year in the market, which made up for my relatively tame vacation in London and Paris, (at least it was tame in comparison to last year's between job trip to Ethiopia and Egypt). Hope that I or Dick hear from you all in the new year.—**Wendy Elaine Erb**, Co-Secretary, 531 Main St., Apt. 714, New York, NY 10044

73 10th Reunion

It's Thanksgiving time and there are a lot of hot turkeys around, in addition to the ones conferring at the football strike negotiations.

Joan Gilden is doing a fellowship in child psychiatry at the University of California at San Diego, living in North County, San Diego. She just moved there from Los Angeles where she completed her internship and residency in general psychiatry at LA/USC Medical Center. In addition, she has been pursuing her interests in dance, photography, and botany, and generally enjoying life on the west coast. . . . **Roy T. Lydon** is a visiting lecturer at the Yale School of Architecture in addition to other good things mentioned here previously. . . . **Roger Bowers** moved to Sayre, Pa. last April to become an associate in radiology at Guthrie Clinic and Robert Packer Hospital. Wife Denise and he have two daughters, Leslie and Rebecca.

David Laughlin has been appointed professor of metallurgical engineering at Carnegie-Mellon University. David, wife Diane, Jonathan, Elizabeth, Andrew, and Daniel live in Wilkinsburg, Pa., where David is president of the board of directors of Trinity Christian School. . . . **Jon Bryan** retired from the Navy in 1981 and is now employed by Systems Architects, Inc. as technical director for systems engineering in Lexington, Mass. . . . **David Moylan** is pursuing research interests in radiolabeled isotopes' therapy (in immunoglobins) for lung cancer, as well as hyperthermia for superficial tumors. He is assistant professor of radiation oncology at Thomas Jefferson Hospital in Philadelphia.

Ruth and I are girding ourselves for the approach of tax season. By the time you read this, of course, we'll have our refund already. You'll be

happy to know we haven't any idea at this point what we'll spend it on. Perhaps a cup of coffee or a gallon of gas.—**Robert M.O. Sutton, Sr.**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

74

Hello class. These notes come straight out of the holiday season and into the February of your collective life. I hope that all of you are enjoying your winter months in comfort whether you live in southern California or not.

For starters, the class received the coveted "Bronze Telephone Award" in appreciation for our startling performance on behalf of the fall upgrading telethon. Congratulations to our class telethon coordinators **Sandy Yulke**, class president, and **David Shiang**, class agent, and all of you who worked the telephones and contributed so generously. I spent one evening working the telephones at the telethon and gleaning some information for these notes at the same time. I spoke with **David Fox** briefly about his family. He and his wife Paula (Boeckenstadt, Wellesley, '74) have a nine-month-old daughter, Sharon. . . . **Roger Goldstein** and his wife are the proud parents of seven-month-old Todd who was born on April 30, 1982. . . . **Howard Herzog** is working as a chemical engineer for Aspen Technology in the synfuels area. . . . **John Sheetz** (who is never at home when I call) received his master's degree in architecture according to his wife Allison (who tells me more than John ever did). . . . **Neil Cohen** and his wife Amy Bona (Wellesley, '75) now have a daughter, Emily Bona-Cohen, who was born July 9, 1982. Neil is an associate professor of Law at Seton Hall University. . . . **Jerry R. Kramer**, M.D. is now the chief resident of dermatology at the University of Miami School of Medicine. He is planning the opening of his Miami office next year.

Arnold Schiemann and his wife also have a new daughter, Veronica, born June 2, 1982. Arnold is now vice-president of the Bogota Telephone Co. (over 700,000 subscribers) and is involved in telematics, which he describes as the study of computers and communications. . . . Virginia and **John DeLuca** and their two children John (2 years old) and Stephen (11 months old) are now living in Kulpsville, Pa. John is a senior research toxicologist at Merck, Sharp, and Dohme in West Point, Pa. . . . **Charles Aden** and Elizabeth Dickie were wed on June 27, 1982. Elizabeth is a medical anthropologist who spends her time studying hepatitis virus. Charles is currently a one-quarter owner of a small electronics firm in Sunnyvale, Calif. He says that the income side of the balance sheet is somewhat light. (But then it's tax time, right Chuck?) Charles and Elizabeth had their honeymoon in the South Pacific somewhere. (The notes I get are never too detailed.)

Steve Projan received his Ph.D. from Columbia University in 1980. He is now conducting research on bacterial plasmids at the Public Health Research Institute in New York City. If he can find the cure in time, the people of New York will be saved . . . or altered in some fascinating way. . . . **Janet Stoltz Sunnes** has finished her residency in ophthalmology (somewhere). She and her husband (not identified in this communication) have two children, Avrami who is 5 years old and Akiva who is almost 2 years old. . . . **Vivian Loftness**, please send me your address. I tried to reach you during the telethon. I hope the number is correct. Vivian has been active as an energy consultant for various federal agencies as well as private firms. The list enclosed for these notes is unfortunately too long to print, but it does explain why she is not at home sitting by the telephone waiting for me to call. Keep up the good work.

Fugio Hayashi has gone to Tokyo for a one-year assignment. He says that he is enjoying being back in Japan after living in the U.S. for 18 years. . . . **Bruce Schobel** has been working as an actuary with the National Commission on Social Security Reform. The Commission's report (due December 31, 1982) should be out as you read this column. Bruce says that the Congress will have to implement some changes in the current law due to the fact that social security will be unable to cover its benefit payments by July 1983 under present law. So retire now, while you still can.

Meanwhile, closer to Cambridge, **David Sullivan** who is a Cambridge city councilor, has spoken out against M.I.T.'s purchase of 8 new condominium townhouses in Cambridgeport as "unlawful." The issues are historical and convoluted in this case. For further information, contact David or Walter Milne, special assistant to the president for urban affairs (M.I.T.).

More political news: **Chuck Rosenblatt** was elected to the Brookline, Mass. town meeting and also serves on the town's finance board as the chairman of energy and libraries. Less political news: he married Miriam in August. He is now back at M.I.T. over at the magnet laboratory (Bitter) squeezing NSF for grants to fund his work in chemical physics. (Chuck, thank you for the letter. The rest of you should follow his example.)

One of our classmates is now in print in a way that is of particular importance to those of us who must survive the traffic wars. **Richard Trachtman** and Ira Gershkoff have co-authored *Wild in the Streets: The Boston Driver's Handbook*. Published by Addison-Wesley in trade paperback form last September, it is a survival manual for the uninitiated.

Now I will take these notes to the *Review* office at breakneck speed as prescribed in the publication above. It's 3:00 a.m. I should be able to drive the five miles in about four minutes. Good morning and don't do what I do.—Co-secretaries: **James Gokhale**, 12 Pond Lane No. 54, Arlington, MA 02174; **Lionel Goulet**, 34 Tremlett Square, Dorchester, MA 02124

76

The news from the mails has been quite sparse. Please write. First of all, a note from **Gail Rubin**. "I'm still working for Bolt Beranek and Newman Inc in Cambridge. I've been there since graduation—how many classmates have been doing the same thing after six years? In November 1980 I bought a townhouse condominium in Watertown, and I enjoy having my own place. In my spare time, I'm a folk dancer (twice a week at M.I.T.). This summer, I took a lot of vacation and went to Israel for two weeks, spent a week in Vermont bicycling, and spent another week at folk dance camp in New York. . . . Another classmate of ours, **Bill Anderson**, married Laurie White last October (1981), and he got his Ph.D. in mechanical engineering in June (1982). They moved this summer to Ponca City, Okla. where Bill is working for Conoco."

And a note from **Richard McAdoo**, with an important correction. "Imagine my surprise to see myself mentioned in the October 1982 issue as having a 'happily libertine' nature. Perhaps in today's permissive society this should be construed as a compliment. However, I feel obligated to point out that I am a *libertarian*, not a libertine. Could you please issue a correction immediately, if not sooner? Otherwise, I may have to refer you to another quite similar word which I am sure you know—*libelous*. (Correction noted!) . . . As you can see from this note, I did make it to Scotland and England on vacation. I highly recommend to all a trip to London, particularly St. Paul's Cathedral, for the architecture and history."

From **Daniel Christman**: "Although not among those listed (I tried to keep tabs on everyone, but . . .), I, too, was present at the 5th Reunion in June 1981. I recently completed two years service in the engineering division of Rohm and Haas Co. This is my longest period of employment with any one company. Most of my work is in the development of enhancements to the FLOWTRAN process simulation system. We should have ASPEN in soon. I also work on modeling dispersion of containments in air and water and have contact with regulatory agencies concerning allowable emissions. I keep busy evenings by playing in a half-dozen community symphony orchestras."

As for your secretary, he nearly had his shirt and skins plucked from his back during the bond market rally (I was short). I am still reeling a bit from it, but some coffee and Swiss franc trades are helping to put things right. However, I do have a ways to go. Those bond futures can be extremely nasty if one gets caught on the wrong side! I am also having quite a bit of fun with stock index futures. Finally, the ultimate stock trading instrument. Imagine buying or selling the entire stock market at a whack. It can be both fun and frightening, as any good speculative vehicle should be.

Please remember to write. Any items of news would be greatly appreciated.—**Arthur J. Carp**, Secretary, 15 Jones St., Apt. 3D, New York, NY 10014, (212) 741-3023

77

(Editor's note: If it appeared that your secretary forgot to sign off last issue (January), it was not her error but rather a gremlin at the production table who, during the holiday excitement, accidently cut the last paragraph off the '77 column.)

Hurray! I'm finally getting a bit more mail and will not have to struggle so hard to write more than a two-paragraph column.

David Dobos writes, "For the 50 plus '77ers who braved the unusually blustery mid-June Boston elements, returning to M.I.T. for the class reunion festivities was well worth the effort. Friendships were both renewed and begun. Learning of classmates' experiences and achievements, seeing the Institute in a new light, and observing the enthusiasm exhibited by more-veteran alumni rekindled a special pride and affection for a place that has so profoundly influenced its 60,000 graduates.

"We will remember the visit of Paul and Priscilla Gray to our Saturday noon barbecue as well as the collective recognition we received at the announcement during the Technology Day luncheon of a first-ever (for M.I.T.) five-year class reunion gift. Although the itinerary of concerts, programs, receptions, and meals afforded opportunities to catch up on five years' events, the lasting memories from our 5th Reunion will be of the spontaneous activities undertaken in addition to those scheduled.

"Fourteen crazy classmates traipsed through downtown Boston to a late showing of *Star Trek II (The Wrath of Kahn)* and critiqued the movie at a nearby watering hole afterward. At the Sunday morning Endicott House brunch, a copy of the complete (24 verses) 'M.I.T. Drinking Song' (you remember—'We are, we are, we are, we are, we are the Engineers . . .') was discovered, then distributed to and sung by aroused classmates. The event which will longest be recorded (literally) was a late night excursion to the Harvard Bridge by a rather resourceful quintet. Weathering cold, wind, and the MDC police, the fivesome restored to prominence the painted '77 Smoot mark. Once a fading green, our class year now shines forth a brilliant fire engine red, awaiting similar action at our next quinquennial event.

"Those that were there enjoyed the reunion immensely and anticipate an even bigger celebration in 1987."

Dan Fairweather and his wife Mary welcomed son Joseph Daniel to their family on August 6, 1982. They, along with daughter Rebecca, are living near Lapeer, Mich. Dan is working in the research department of AC Spark Plug in Flint. . . . **Harish Dadoo** has left investment banking to start his own company specializing in real estate portfolio management, financial consulting, and venture capital, along with some former Harvard and Stanford classmates. His company, Callistar S.A., is in Mexico City. . . . **Joel Weingarten**'s

firm, ARTEK, specializing in energy-efficient architecture and construction, has just been awarded an open-ended design contract with the U.S. Navy.

Dawna L. Paton has been named assistant product manager for "TK!Solver," a software product of Software Arts, Inc., after working for Environmental Research and Technology, Inc. . . . **Deborah Stutman** notes, "Nothing new. Maybe one year to go." Please tell us more—I'm curious if no one else is, Deborah.

A long letter from **Thomas C. Mills**, M.D. brings all sorts of news about many alumni. Thomas moved to San Francisco to start a psychiatry residency at the University of California after graduating from the University of Illinois College of Medicine and spends most of his free time active with the Bay Area Physicians for Human Rights. Thomas shares an apartment with Steve Roy, '73, who is finishing up his Ph.D. in environmental geology. Other persons in his program at UCSF include Alan Freeland, '74, who is now chief resident, and Andrew Pauli, '75. Also at UCSF are Mary Lou Selbrig, '75, a neurology resident, and medical students Laura Rees, '79, and Al Czerwinski, '76. Outside of medicine, Thomas has run into Scott Chase, '78, **Eric Black**, Jim Orban, '75, who is in training for the San Francisco police force, Naomi Pless, '78, Peter Berke, '78, and Myu Campbell, '76, who has received her health physicist certification, and is moving up the governmental ladder at the Nuclear Regulatory Commission in Philadelphia.

Finally, Class of 1978 would like to invite recent classes who have friends in '78 to please feel free to attend their reunion this coming spring. If you are interested, please contact Rita L. Russell, '78, at 86 Brooks St., Medford, MA 02155, or call (617) 395-6859.

That's all the news for this month; thank you for writing to your class secretary.—**Barbara Wilson Crane**, 6431 Galway Dr., Colorado Springs, CO 80907

78 5th Reunion

Think back with me for a moment. Think back to warm Mays and Junes in Cambridge, to clear blue skies and new leaves on the trees, to lying out on the Student Center grass in short-sleeved shirts. Think back to all the last-minute flower planting and repairs that physical plant always started just as finals week started to roll around and the weather started to get really nice.

This brief respite was brought to you by your reunion committee, who wants to remind you that this year, all the late-planted flowers, repairs, freshly mown grass, and beautiful New England spring weather is for you this time around. Yes, our 5th Reunion has arrived, and now is the time to plan to attend. Now, before other things start to crop up, before it's too late to make plans to come to Cambridge. And all of us should make every effort to be there.

The reunion is our party, our chance to celebrate, reminisce, and renew, run by us and for us. A lot of careful planning has gone into this reunion—but all the planning in the world isn't going to make this a good party unless *we* respond and participate. So get on the phone and call your old roommate, fraternity brother, best friend, or lab partner and plan to get together at the reunion. There will be planned events, semi-structured events, and plenty of free time to wander around Boston and M.I.T. and see new developments and old friends. Be there. There are no excuses. . . . well, few excuses. **Rita Russell** has a good excuse. She's getting married that weekend. (The sub-committee on excuses met and voted 4-3 to accept her excuse, after extended debate.) Rita will wed Jeffrey Rosensweig, a former Yalee getting his economics Ph.D. at the 'Tute. They'll travel to southern France for their honeymoon.

Returning to your regularly scheduled gossip column. . . . let's start with some of our medical personnel. **Carl Krasniak** got his M.D. from the University of Rochester last May and is presently a surgery resident at the University Hospital of Cleveland, affiliated with Case Western Reserve University. Carl reports that fellow Phi Bete **Ken Schreibman** is a grad student at Case Western. **Lann Salyard** will be graduating from the University of Pennsylvania Medical School this coming May. She is going into family practice and hopes to do her residency training in Philadelphia. . . . **Barbara Ostrov** writes that she is finishing up med school at State University of New York, Buffalo. This July she'll start in a four-year program which combines internal medicine and pediatrics; also, she'll spend this February working at the Brigham and Women's Hospital in Boston.

More medical school graduates. **Dan Rahman** writes: "I graduated from New York Medical College in June and moved to Boston. I am now doing an internship in internal medicine at Mt. Auburn Hospital in Cambridge." . . . **Barry Linder**'s note is too good to be summarized. He says, "I'm in my third year of med school at Washington University in St. Louis and having a great time, but I sure could use a few mountains and just a little bit of the Cape. I still spend most of my free time following events at NASA. After working at NASA-JSC in Houston and getting to be a test subject on their KC-135 zero-G plane, I just think the space program is great! By the way, has anyone heard what medical school **Ben Kerman** went to?"

One other medical note. This Thanksgiving weekend, classmate **Al Presser** was visiting New York City when he got into a minor automobile accident. Alan was taken by ambulance and delivered into the hands of **Arnie Aigen** for treatment. (Arnie is a resident at Jocoby Hospital in the Bronx.) Alan is recovering well; Arnie is still receiving treatment from the encounter.

Moving along . . . I am told by a reliable source that last Halloween a large gray elephant was telling stories about me at a party in Winchester, Mass. The elephant worked in advertising in the Boston area and is married to a woman with short curly hair. Who are you?

A quick note from **Herman Marshall**, who just got back from Italy for a month of mixed work and play. Herman's astronomy Ph.D. is due this June, and at last glance, things were on schedule. Herman's work has been examining the evolution of quasars with data from the "multiple mirror telescope at the Fred Whipple Observatory" and the orbiting X-ray observatory, *Einstein*. . . . **Fern Crandall DoVale** got her master's in civil engineering from Columbia University last summer. Fern has now been elected membership vice-president of the M.I.T. Club of Northern New Jersey and is actively seeking out new members.

Our former Undergraduate Association president, **Peter Berke**, has been located, after dropping out of sight for several years. Peter is presently doing consulting in the field of computer applications to politics and political polling. His note says that he is living in "SM CA," which I assume is Santa Monica, Calif. . . . **Vonnetta Clark** writes to inform us that she now has her master's of architecture from the University of California, Berkeley. . . . **Scott Bernard** has joined the ranks of our class legal staff. He's practicing law in New York City with the firm of Winthrop, Stimson, Putnam, and Roberts.

Larry Siegel is enjoying life in Brookline, having recently moved from Jamaica Plain. He recently had the pleasure of visiting fellow classmates **Jim Harrison** and **Pam Hall**, who have moved back to Dorchester after a year in the beautiful Livermore Valley. . . . Meanwhile, back out in California, is **Rob Greenberg**, who is living and working in Sacramento, Calif., where he has been for the past three years. He is working for General Dynamics and enjoys California, especially the weather. "The scenery all over the state is spectacular, especially the view from 14,000 feet up on Mt. Shasta."

Sheila Luster has now left active army service (she's still in the reserves). She has just left her last assignment in Korea and will join Kevin Wade, '79, in Tucson, Ariz. Sheila will "enter the civilian civil engineering workforce," while Kevin continues in the Air Force. . . . **Steve Piet** spent the summer of '82 traveling around the country (12,000 miles!) and "becoming human after eight years of M.I.T." (bachelor's, master's and Ph.D. in nuclear engineering). Steve is really enjoying EG&G, Idaho, and the beautiful surrounding Idaho Falls. He's enjoying the change in the meteorological, social, and political climates after all those years in New England

I want to stress the main reason for you to come to the reunion—FUN. I promise a minimum of speeches and formalities and an emphasis on the parties, get-togethers, softball and sailing. And the more of us that come, the better it will be. If you need more convincing call or write to me at the address below.

My news? I have started my new job as a civil servant, and I love it. I am working as staff counsel at the Massachusetts Health Care Rate Setting Commission doing some policy work and litigation. We have a great staff of young attorneys, and our work involves many innovative programs to cut health care costs in the Commonwealth. Married life, well into its second month, continues to be fun. Keep those cards and letters coming—especially those boring post cards; I didn't get any this month. Until next time, this is **David S. Browne**, Secretary/Treasurer, 50 Follen St., No. 104, Cambridge, MA 02138, (617) 491-5313

79

Hello again, classmates. Hope this column finds you all well and productive. **Marla Eglowstein** writes from Grenada in the West Indies, where she is a second-year medical student. "I've had a great year here. No hurricanes or revolutions, plenty of bugs, and a male/female ratio much like M.I.T.! School has been tough—the equivalent of taking 5.42, 5.60, and 18.02, if not worse! But I've done well, and I'm attempting to transfer to an American med school. This school has a very similar curriculum, and the student body is 95 percent American. No, we don't spend all our time on the beach! During the past summer, I spent eight weeks at home relaxing and working with my old pediatrician. It was terrific and really got me into the spirit of being a doc." Marla reports that **Gerry Scheinman** was previously a student at her school, winning the Golden Scalpel award in January 1980 for being the best anatomy student but has since transferred to an American school (Gerry, drop me a line and fill us all in).

Dave Soule dropped me a line from his native New Jersey. In addition to his job in the international division of American Cyanamid, Dave writes, "I experienced the other side of the classroom, teaching undergraduates at Montclair State College the 'fundamentals of finance.' I never fully realized the amount of work and energy that goes into teaching a course. My previous professors made it all look so easy! I look forward to continuing teaching this spring." At press time, Dave was doing lights for a local production of *South Pacific* as well.

Paul Hoffman is now a consultant and technical writer (no programming!) in the computer biz. "Still enjoying lots of that Berkeley sex-and-drugs-and-rock-and-roll!" . . . **David Tuckerman** is working on a Ph.D. in electrical engineering at Stanford. He received the first annual IEEE Paul Rappaport Award for an outstanding paper in an electron devices publication. Congrats!

So much for the California contingent. Here in the Big Apple, **Andrew Weiss** graduated from Columbia Business School, spent a summer relaxing (including a month in Italy), and is now an associate at Booz Allen and Hamilton, the management and technology consulting firm, in their New York office. Welcome to the M.B.A. world, Andy! . . . **Susan Ann Silverstein** is in her last year of Columbia Law School. She writes, "I'm currently facing a bleak job market. Cuts in federal funds

and other byproducts of the recession have limited the ability of public interest and legal services organizations to hire, and these are the places I am looking at. I'm hoping to do some kind of civil rights or poverty law. Last summer I worked at the Institute on Law and Rights of Older Adults on issues related to the elderly poor. I'm still writing poetry and still explaining to everyone who sees my resume why I went to M.I.T.!" . . . **Deb McKechnie** spent three years working for the Commonwealth of Massachusetts Department of Environmental Quality Engineering as a senior sanitary engineer. She's now a student in the Environmental Engineering Department at Manhattan College as an EPA Fellow. Deb writes, "Life in the Bronx is okay, but I'm homesick for Massachusetts."

At press time, **Kevin Wade** was a lieutenant in the Air Force, stationed at Osan Air Base in Korea. By now, he will have been reassigned to Tucson, Ariz., for a two-year stint "flying the OA-37 (Dragonfly) and enjoying it." . . . As for moi, by the time you read this I will have started the fourth of my four rotations as a financial associate with Mobil Corp. Only a few more months, and I'll have a "real job!" More on that later. In the meantime, keep (start?) writing.—**Sharon Lowenheim**, Secretary, 131 E. 83rd St., Apt 2G, New York, NY 10028

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This is a long column, not just because I missed a column last month, but also due to the increased number of people contributing to the Alumni Fund and writing notes on the cards they sent in. But before the class news, here's an announcement from Rita I. Russell, '78, who is helping to plan the class of 1978 fifth year reunion. She asked me to pass an open invitation to members of our class. For more information, contact Rita at 86 Brooks St., Medford, MA 02155, or phone (617) 395-6859 (home) or (617) 253-6148 (work).

John Small and **Mary Halm Small** are caretakers of the Theosophical Society building in Boston. Mary is also a research assistant at Harvard Dental School and is applying for graduate school at Boston University in computer science. John has returned to school (U. Mass. Boston) in psychology. . . . **Charles Hoffman** is a third-year graduate student at Tufts Medical School, department of microbiology. his wife, Linda Lepnis Hoffman, '82, is working at New England Biolabs. They recently bought a house in Beverly, Mass., north of Boston. . . . Also north of Boston is **Steven Frann**. Steve jumped from *The Tech* to *Mini-Micro Systems* magazine, where he is the new products editor. He is living in Salem, and has joined a health club in Marblehead.

It seems many classmates just can't get enough of that good clean education: **Finley Shapiro** is a Ph.D. student at—where else?—M.I.T. Finley is in the Department of Electrical Engineering in area V. **Barry Star** is attending Stanford Business School. . . . **Richard Fastow** is working on a Ph.D. in materials science at Cornell University. . . . **Chien Huang** is pursuing another "intangible object": a Ph.D. at Princeton University's Mechanical and Aeronautics Department.

Paul Homsy is in his third year at the University of Texas Medical School in Houston. . . . **Peter Reilly** recently moved to Chicago and is studying for an M.B.A. at the University of Chicago Graduate School of Business. . . . **Peter Menell** has finished a Ph.D. in economics at Stanford, and has now started on a J.D. program at Harvard Law School. (Whew! How long ago did we graduate?) . . . **Nancy Breen** has started a graduate program in geophysics at the University of California at Santa Cruz, after spending the summer bicycling from Jasper, Alta., to San Francisco. (She says hello to all the M.I.T. ruggers out there!)

After two years of working for Mass. General Hospital as a laboratory technician in a molecular biology lab, **Tom Vasicek** decided to return to school. He has begun graduate studies in the Biological Chemistry Department of Harvard Medical School. Tom spent two months last summer backpacking in the Canadian Rockies and the Sierras with Liane Pelletier (Wellesley '80). Tom and Liane are living in Belmont, Mass.

From **Steve Mickel**: "Fellow Deke **Gerry Eastman** and I are joining each other at Harvard Business School this fall. Gerry has been working for Teradyne, near South Station; I've been at Rohm and Haas's Houston plant. Houston has been kind of fun. Besides tennis and softball, I was able to play ice hockey down here in a league of transplanted Yankees, Canadians, and over-the-hill ex-pros." . . . Also at Harvard Business School are **Debe Utko**, **Frank Wojtowicz**, and **Kate Mulroney**.

Have you heard of a company from Beaverton, Ore., called SemiDisk Systems which builds disk emulators for microcomputers? After spending one and a half years with Intel Corp., **James Bell** decided to quit and form SemiDisk Systems. He even sent me a slick marketing brochure. . . . **Kevin Wallace** has joined the rash of people who have headed out to California to work for Hewlett-Packard. Kevin is working in the computer systems division in Cupertino. . . . And frolicking around the northwest (exact destination unknown) is **Steven Hazlerig**. Steven is working hard on microcomputer software systems for Microsoft, Inc. He's also been doing some skiing and bicycling. . . . **Mitchell Gaynor** is a financial systems analyst for Sattlebrook in Cambridge. . . . **Rich Clemenzi** is a computer systems analyst in Washington, D.C.

Martha Griep and her husband, Jonathan, '81, are engineers at Honeywell Solid State Electronics Division. Jon is a bipolar device engineer, and Martha is in design automation. When I heard from them, they were enjoying the Minnesota autumn (a lot like New England's), but were not looking forward to winter. They were back in Boston over Thanksgiving, making sure to stop at M.I.T. and hit the Coop bookstore. . . . **Bryan Bentz** is consulting for the M.I.T. campus police, installing a record keeping system. He is also doing software work in underwater acoustics at Bolt, Beranek, and Newman in Cambridge. . . . Speaking of BBN, I am still employed there, currently in the Communications Systems Division, and working as hard as ever. I recently attended a week of meetings in Stuttgart, Germany, for BBN. Other things that are keeping me busy include interviewing prospective M.I.T. students (as an M.I.T. Educational Counselor), and taking a German class two nights a week. Next week I will get to relax, however. I will be heading out to San Francisco for my longest vacation since our senior year at M.I.T. But my mailbox eagerly awaits the usual juicy tidbits of information about classmates.—**Ken Turkewitz**, Secretary, 3 Winslow Rd., Belmont, MA 02178, (617) 489-2441

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Boston is currently enjoying amazingly warm weather, for December. In fact, today produced a record breaking high temperature for this date in history. (By the way, exactly a year ago, we were in the midst of a blizzard.) When I see this in print, I'm sure I will have already had my fill of snow so I'm going to savor the warmth while it lasts.

Heard from a few classmates over this past month—as usual, it's fun to hear from you and certainly appreciated. **Anita Bliss** writes: "I've been busy at Shugart Associates designing a half high 5 1/4-inch rigid disk drive in product development. Continuing my involvement from M.I.T., I'm very active in the San Francisco Bay area section of the Society of Women Engineers (SWE). Currently, I'm college relations chair.". . . Also on the west coast is classmate **Robert Lucero**. Robert writes: "I have been working for Hughes Aircraft Co. in Fullerton, Calif. for the last one-and-a-half years, enjoying the sunshine but missing the good old days in Boston. My three roomates from freshman year still haven't graduated yet! But it's only six years later."

I received a nice note from **Harvey Woeklck**. Harvey tied the knot on July 10, 1982. His bride is Heidi Pughe, a Smithie, of course. **Jeff Green** was the best man; **Matt Lynch** was an usher. Dr. Ingrid Gutberg (formerly of M.I.T.) played the organ and Dr. Hale Bradt, professor of physics at M.I.T., was a guest at the wedding. In August, Heidi and Harvey attended Jeff Green's wedding. Jeff and his wife Barbie are living in San Diego. . . . **Donald L. Jones** writes: "I'm adjusting to the isolation and weather of Fort Polk, La. I find myself longing to return for more schooling already! In December, I should become a platoon leader for 46 mechanics. We will be turning wrenches to provide peace through strength in the 5th Infantry Division. I've been investigating ways to enjoy Fort Polk. I played the lead in a romantic comedy and am now looking at the 'techie' side of theater."

Victor Miller is currently working as a systems analyst for Loral Electronic Systems. . . . **Drew Ladau** and **Mitch Handler** are happily working for GE in Louisville. . . . **David Yamaki** writes: "I've finished up my first year working for Mobil. It's not what I thought it would be like, but I'm still not ready for more school. Fortunately, there's still plenty to keep me busy after work!" . . . **John Card** spent the summer on vacation in northern Italy and is now pursuing a Ph.D. in chemical engineering at the University of Wisconsin.

Finally, a heartfelt congratulations go to my good friends, **Josh Littlefield** and his fiancee, Suzy Groves (Wellesley, '81) on their recent engagement. Josh and Suzy will be married this July 17 in the Wellesley College Chapel. (Yippie!) Keep those cards and letters comin'.—**Chuck Markham**, Secretary, 362 Commonwealth Ave., 2E, Boston, MA 02115

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Welcome to another edition of the Class of '82 notes. I've been asking why people don't write, and a lot of you say that it seems the only people who write do so to tell you they've won their latest Nobel Prize. Not so! **Steve Taylor** writes to say he is "unemployed and unpublished." At least now he's no longer unpublished. He made plenty of excuses why the rest of you probably haven't written. (I'm beginning to feel like your mother—"Why haven't you written?") He says you're all probably getting used to new jobs, areas, schools, and lifestyles and that writing your classmates is a low priority—can you imagine that?! Hell, I write almost every month! Steve also sends news of other classmates. **Shawn Sullivan** and **John Tenney** completed a month of training in Wilberforce, Ohio (is that a real city's name?) and are working in the Peace Corps in Kenya. . . . **Doug Finch** and **Marc Gronet** are both working on their master's degrees in Course XVI (aeronautics and astronautics for those who may have forgotten) at the 'Tute.. . . **George Paoletti** is working for Martin Marietta in Denver. It'll be wedding bells for he and Ruth Schmidt (Wellesley, '83) in June. . . . **Rich Epstein** is in med school at Brown . . . **Greg Farnigho** is in med school at Jefferson. Thanks, Steve, for all that news!

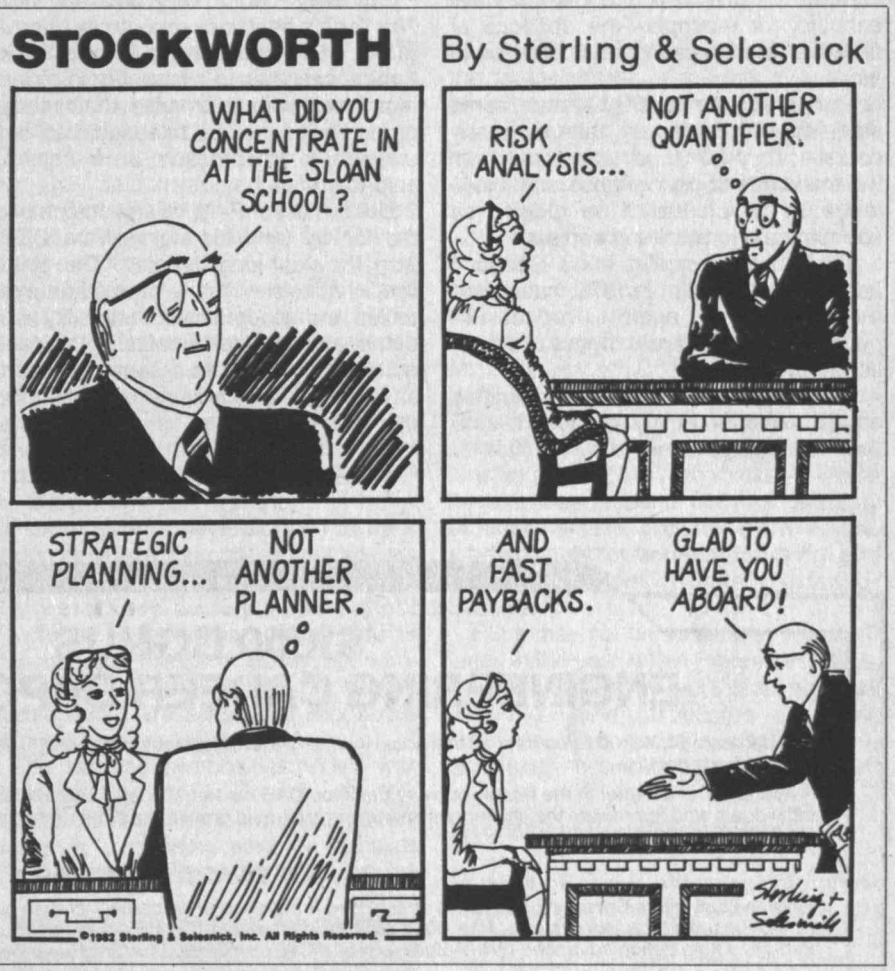
I received notice from the ASTM that **Michelle Gabriel** was the 1982 Mary R. Norton Memorial Scholarship Award recipient. Michelle is co-oping at IBM, East Fishkill and will be writing her master's thesis on her work. Congratulations Michelle!

Does anyone know what's happened to **Paul Czarnecki**, **Cheryl Wheeler**, **Thomas Popik**, **Janice Mayer**, or **Jonathan Koch**?

Charlie Frankel has graduated. Do you wonder whatever heppened to so and so? Let me know and I'll see if we can find out what they're doing.

Not much news with me—I've gone back to all those things I enjoyed before I was an M.I.T. student. You know, playing the piano, sleeping, and eating regularly. Keep in touch!—**Rhonda Peck**, 38 Bigelow St., Cambridge, MA 02139

Stockworth of Stockworth, Ltd., interviews a Sloan School graduate. This panel, especially prepared for M.I.T., is typical of the Stockworth, Ltd., adventures which now appear daily in at least five U.S. newspapers. Herbert Selesnick, '62 (left in photo) writes the strips—mostly on the basis of 15 years' consulting experience with Harbridge House, Inc., Boston—and Hinda Sterling (they met at Harbridge House) draws them.



Cartooning a Wry Look at Business as Business Is

Herbert L. Selesnick, '62, had 15 years at Harbridge House, Inc., management consulting and analysis firm, to observe the incongruities of business, and his partner Hinda Sterling had a few years there, too, following her training in graphics and lithography at Pratt Institute.

Then they went to work in Beverly—a consulting company specializing in communications skills training, and a comic strip designed to have fun in a light-hearted way with some of the assumptions and habits of modern management.

Their messages are fashioned into dialogues across the desks and around the drinking fountains of Stockworth, Ltd., where a cast of nine employees conduct a business whose business is apparently just staying in business. Selesnick and Sterling say they are neither liberal nor conservative—they're "down the middle," and they try to depict business people "in their best and worst lights"—as they really are." Their goal is give their readers a wry look at business practices and business people.

Stockworth appears daily in the *Boston Globe* and four other newspapers, and negotiations are now under way for national syndication. No piece of cake, say Stockworth's authors. Each strip takes two to four hours to complete, a process that includes writing, rough sketching, and final drawing. "I thought this was going to be simple," she told her local newspaper. "Sometimes it's very hectic around here. It's crazy. We work long hours."

A Pass/Fail System with Grades? Yes, but the Grades Are Invisible

The goal of pass/fail grading for freshmen is simple: take enough academic pressure off students so that they can make the most of their first year at M.I.T., including exploration and risk-taking as well as adjustment to new freedom and responsibility.

But there are problems: students graded pass/fail have no certain idea of where they stand in the class—whether they've done well or just well enough. And for students who want to go into competitive graduate schools—medical schools, for example—the absence of first-year grades can be a serious problem.

Tempted by the pass/fail system, some students, say the faculty, take too many courses; they fail to come to terms with the standards of performance and excellence by which they'll be judged as sophomores, juniors, and seniors.

Yet Paul E. Gray, '54, in his inaugural address as president in 1979, had asked the faculty to try again to reduce unnecessary academic pressures on undergraduates.

Weighing these issues, the Committee on Educational Policy proposed—and the faculty approved late last fall—a change in the pass/fail system: instructors would be required to submit "internal" grades for freshmen in the second term. Those grades would be communicated to students and advisers, but the registrar would not put them on permanent records. Such "internal" grades would substitute for the evaluation forms which have heretofore been used at the end of the spring term, and the evaluation process at the end of the fall term—as well as other counseling programs—would be strengthened.

The faculty's approval was expected—almost routine.

Student's had a very different view. *The Tech*'s headlines repeatedly referred to the CEP's "hidden grade plan." "Returning freshmen to a formal grading system, even with a promise that internal grades will never be released, can only exacerbate the pressure on freshmen," said the editors.

But Professor Felix Villars, chairman of the faculty (and therefore of the CEP), won the year-long debate. "The objective," he insisted, "is to strengthen evaluation and academic accountability without weakening the benefits of the pass/no credit system." In a sense, a way to save pass/fail from its conservative faculty critics.—*J.M.*

Alumni: Stars but Losers in Track

For the ninth time in ten meetings, the varsity prevailed—this time by a score of 79½ to 33½—in the annual varsity-alumni track meet on December 11.

Despite the final score, the 20 former M.I.T. stars came through with several outstanding performances. David Wilson, '73, won the pole vault with a leap of 14 feet—just four inches short of the facility record. Jason Tong, '79, won the high jump at 6 feet, 4½ inches while Pat Hamilton, '81, captured the 3,000-meter run in 9 minutes, 13.67 seconds.

The alumni squad had five second-place finishers: Brian Michon, '82 (weight throw), Sumner Brown, '66 (1,500-meter run), Greg Hunter, '76 (shot put), Lew Bender, '81 (pole vault), and Tong (triple jump). Tong's effort of 41 feet, 10½ inches in the triple jump was just three-quarters of an inch behind winner Eric Weaver, '83.

Paul Miller, '82 (55-meter dash), Jeff Lukas, '82 (800-meter run), Bob Collins, '82 (3,000), and Max Klein, '81 (high jump) all finished third for the alumni.

Though lack of depth hurt the grads, "we all had a good time," said Wilson, and Tim McManus, '80, warned the varsity to "wait until next year."

—*Ken Cerino*

Honoring 30 years of service. When he stepped down last June, Edward R. Marden, '41, had been president of his class for more than 30 years—since the tenth reunion in 1951. Reason enough, judged a group of his classmates, to surprise him with a rememberance—presented last fall at a Faculty Club luncheon by Ed's successor as president, John F. Sexton (right).

D. N. Wormley

Structural Engineers: Can They Rebuild the Built Environment?

The "three wise men of structures" are retiring too soon. The study of structural engineering and the work of those who practice it have only just begun.

The "three wise men" are Professors John M. Biggs, '41, Robert J. Hansen, Sc.D.'48, and Myle J. Holley, '39—all recently retired after careers on the M.I.T. faculty that began as they concluded graduate study at the Institute. More than 50 of their former students and colleagues returned to the Institute late last fall for a two-day tribute in the form of a symposium on current issues in research, teaching, and practice of structural engineering. As the symposium proceeded, it was clear that despite the monuments of knowledge and people credited to the "three wise men," a large agenda remains unfulfilled. Indeed, most of the speakers emphasized the limitations and frustrations of the present state of structural knowledge.

"My contention is that, in spite of all our present analytical capability," declared William J. Hall, professor of civil engineering at the University of Illinois (he was the only non-alumnus on the speaking program), "we still do not know how to design a structure to resist an earthquake. We have paid too much attention to how to analyze things and too little to how to design them."

Structural engineers have an advantage they seldom appreciate, said Professor Holley: Engineering structures tend by the nature of things to fail in a ductile mode—that is, they deform gradually, bending a little at a time and giving everyone warning that trouble is afoot. Brittle failure—the sudden collapse of an apparently sound structure—is rare except during construction. (The exception, of course, is corrosion failure such as of a bridge; but what if everything had to be built in glass? asked Professor Holley to demonstrate his point.)

Few engineers have stopped to think of ductile failure as a gift almost without price; simply by the nature of our materials we achieve ductility in most of our structures. But there is another side to that coin, said Professor Holley: economical inspection and testing to predict ductile failure are essentially impossible with present-day technology.

The two-day symposium ended with Professor Jerome J. Connor, Jr., '53, head of civil engineering at Northeastern University, proposing what he sees as the ultimate challenge to structural engineers: Can we take our rightful role in the "massive task of rebuilding the U.S. infrastructure"? His answer: not unless we can learn to be more efficient and innovative designers, and only if we can capitalize on new high-strength materials—steels, composites, and concrete. And those things cannot happen without computer-aided design and even artificial intelligence in the nation's engineering offices.

All this suggested to Professor Joseph M. Sussman, Ph.D.'68, head of the department at M.I.T., the need for a "complete rethinking" of the educational process in structures. Computer-assisted teaching is the key, he thinks: it will at once release students from the drudgery of analysis and prepare them to use modern tools for sounder creativity and less empiricism, thinks Professor Sussman.

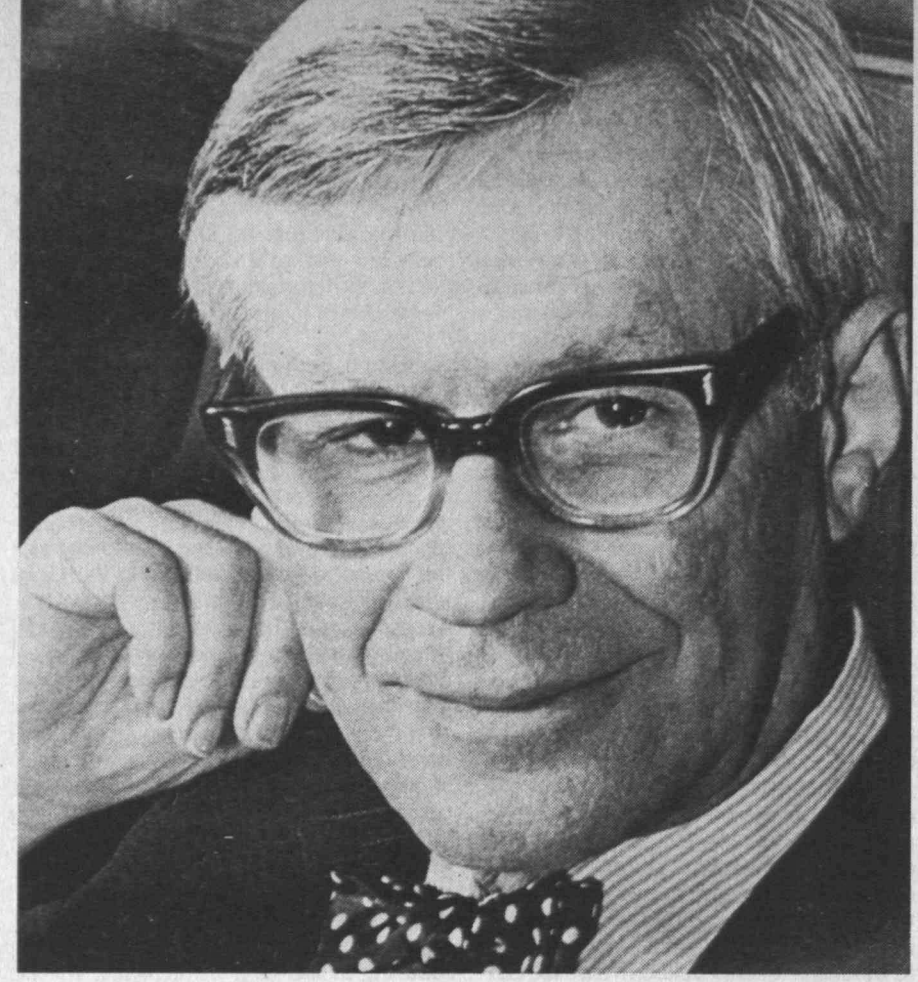
But it may not be so simple. The challenge in the past, when Professors Biggs, Hansen, and Holley were teaching, was to *build*—new structures and new facilities. Can today's challenge—*re*building—be made as exciting?—*J.M.*

While structural engineers were pondering their roles in rebuilding the nation's sagging infrastructure, Michael Dukakis, then governor-elect of Massachusetts, joined the Civil Engineering Department for a day-long symposium marking inauguration of the Center for Construction Research and Engineering. Above: Joseph M. Sussman, Ph.D.'68 (left), head of the department; Frank E. Perkins, '55, associate provost; Governor Dukakis; and Fred Moavenzadeh (right), director of the new center. (Photo: Calvin Campbell)

Mechanical Engineering Head

Professor David N. Wormley, '62, whose recent research has been in analysis and design for transportation technologies, is now head of the Department of Mechanical Engineering. He succeeds Professor Herbert H. Richardson, '53, the latter having been named associate dean of the School of Engineering last summer.

Professor Wormley joined the M.I.T. faculty in 1967 after completing both undergraduate and graduate study (S.M. 1964, Ph.D. 1967) at M.I.T. Beginning in 1977 he was head of the department's Systems and Design Division, and he is founding director of the Vehicle Dynamics Laboratory working in the field of advanced ground transportation technology.



David S. Saxon, '41, says that he "hopes and believes that the perspective gained during my long tenure at the University of California will serve to advance the interests of M.I.T." when he becomes chairman of the Corporation next July 1.

David S. Saxon: A Californian Returning Home to Be Chairman

David S. Saxon, '41, will move into Howard W. Johnson's office as chairman of the M.I.T. Corporation next July 1 after he leaves the presidency of the multi-campus University of California system.

Mr. Johnson announced his intention to retire last June, and since then an *ad hoc* committee of the Corporation has been searching for a successor; the vote on their recommendation of Dr. Saxon, which came at the quarterly Corporation meeting on December 3, 1982, was by acclamation.

At 62, Dr. Saxon—he studied physics at M.I.T. for both bachelor's and Ph.D. (1944) degrees—is a major figure in both science and education in the U.S. He joined the University of California at Los Angeles in 1947 as assistant professor of physics and rose to become full professor in 1958, head of the department in 1963, and soon thereafter dean for physical sciences. Dr. Saxon moved to Berkeley in 1974 upon being appointed provost of the statewide system, and a year later he became its president.

In physics, Dr. Saxon's research interests have included theoretical physics, quantum mechanics, electromagnetic theory, and scattering theory. He's the author of one book on elementary quantum mechanics and co-author of three others and author or co-author of a number of scientific articles.

As chairman, Dr. Saxon will preside over meetings of the Corporation and work closely with the president and senior officers of the Institute.

The committee responsible for recommending Dr. Saxon included Carl M. Mueller, '41, Angus N. MacDonald, '46, and Emily V. Wade, '45. Only once before has the post of chairman gone to someone who was not a former president of M.I.T.: Dr. Vannevar Bush, '16, who was chairman from 1957 to 1959, had been vice-president and dean of engineering before becoming president of the Carnegie Institution in Washington and shortly thereafter taking a leading role in science and technology during World War II. Jerome B. Wiesner, president-emeritus, declined to serve as chairman early last year.

Dr. Johnson, who came to M.I.T. to work in industrial relations as a member of the faculty of the Sloan School of Management, will continue his association with the Institute following his retirement as chairman; he holds the rank of faculty professor, conferred upon him by a grateful faculty when he retired from the presidency of the Institute in 1971.

First Steps Toward a First Sorority

Some 40 coeds who live in Institute houses along "Amherst Alley" have taken the first step toward forming a residential sorority at M.I.T.: they've achieved recognition by the Interfraternity Conference as a temporary member.

The next step is to find a house—a tough job, says Stephen D. Immerman, assistant dean for student affairs. Funds are short and sites hard to find. Perhaps $300,000 a year is available from the Independent Residence Development Fund, Mr. Immerman said, and that limits construction to renovation of existing properties. Going that route requires a change-of-use permit, and that, too, is never easy in Cambridge or Boston, warns Mr. Immerman.

Favorites at the Polls

Seven alumni were successful in bids for major federal and state offices in the elections of November 2, 1982:

☐ **Les Aspin,** Ph.D.'65, won his seventh consecutive term in the House of Representatives as a Democrat representing Wisconsin's first district.

☐ **Marcy Kaptur,** a first-year graduate student in the Department of Urban Studies and Planning, won election to the House of Representatives as a Democrat from Toledo, Ohio's ninth district. She withdrew from the Institute in June, 1982, to organize her campaign, which drew 59 percent of the vote.

☐ **Bruce A. Morrison,** '65, formerly director of the New Haven Legal Assistance Association, Inc., won election to the House of Representatives in Connecticut's ninth district by a vote so close that the outcome wasn't officially declared until November 4; he's a Democrat.

☐ **Donald L. Ritter,** Sc.D.'66, a former staff member at Lehigh University, was returned to the House of Representatives by a wide margin for a third term as a Republican representing Pennsylvania's 15th district.

☐ **Fortney H. (Pete) Stark,** '53, was selected for a sixth term in the House of Representatives from the ninth district of California (Oakland and environs); he's a Democrat.

☐ **John H. Sununu,** '61, formerly a

member of the Department of Mechanical Engineering at Tufts University, is now Republican governor of New Hampshire. He won a hotly contested duel from incumbent Governor Hugh J. Gallen by 1 percent of the vote.

☐ **Howard E. Wolpe,** Ph.D.'67, is back in the House of Representatives as a three-time winner from the third district of Michigan (Kalamazoo). A Democrat, he is a former member of the faculty in political science at Western Michigan University.

Hospital Transformed

Beginning this month, the former Sancta Maria Hospital building next to Baker House—most recently used as the M.I.T. infirmary—will reopen as a residence for 45 to 50 graduate student women. There will be single and double rooms, some with private baths, with shared lounge and kitchen facilities on each floor.

Patricia A. Macpherson, 1921-1982

Patricia Ann Macpherson, administrative assistant for executive education programs at the Sloan School of Management, died on December 6 at Mt. Auburn Hospital, Cambridge, after a brief illness. She was 61.

Ms. Macpherson, a long-time Cambridge resident, had served the Sloan School since 1958. She had increasing reponsibilities for the Sloan Fellowship and Senior Executive Programs, and she was widely known by alumni of both.

Deceased

Willis K. Hodgman, Jr., '11; 1980; PO Box 387, Taunton, Mass.
Hamilton Merrill, '12; November 6, 1982; Tonset Rd., Bx 313, Orleans, Mass.
Charles A. Smith, '13; October 25, 1982; 1224 Boston St., Altadena, Calif.
Ercell A. Teeson, '15; October 24, 1982; 115 Highland St., Southbridge, Mass.
Harold E. Proctor, '17; September 22, 1982; 26 Central Ave., Danvers, Mass.
Donald G. Tarpley, '17; September 13, 1982; Linden Lodge, c/o Helen Penna, 75 Liden St., Brattleboro, Vt.
Maurice Basinow, '21; September 4, 1982; 54 Smith St., Lawrence, Mass.
Leonard R. Janes, '21; June 2, 1982; 2520 Noyes St., Evanston, Ill.
Armand S.M. Kreeger, '21; November 25, 1982; 201 Geranium St., Metairie, La.
Edward C. Layng, '21; March 25, 1982; 28 Forest Dr., Short Hills, N.J.
George Dewey Godard, '22; September 5, 1982; 19 Rose Ave., Marblehead, Mass.
James F. Macintyre, '22; October 1980; Rest Haven Nursing Home, Ballard Hill, Lancaster, Mass.
William Glendinning, '23; September 10, 1982; 5123 Bell Blvd., Bayside, N.Y.
Antonio S. Pitre, '23; November 27, 1981; 31 Yerba Buena Ave., San Francisco, Calif.
Albert S. Bedway, '23; November 6, 1982; 44 Knoll Dr., Hamden, Conn.
George E. Parker, '24; August 18, 1982; Starboard Dr. #73, Cape Elizabeth, Maine.
Marion W. Boyer, '25; November 20, 1982; 63 Baynard Cove Rd., Hilton Head Island, S.C.
Raymond C. Gallagher, '25; October 18, 1982; 526 Hanover, Fall River, Mass.
John E. Handy, '25; October 4, 1982; 1090 Shore Rd., Cataumet, Mass.
Donald A. Henderson, '25; November 28, 1982; 4 Patrick Rd., Westport, Conn.
Georgina P. Yeatman, '25; October 30, 1982; RT 1 Box 744, Beaufort, N.C.
Julius B. Goldberg, '26; November 10, 1982; 5253 Arlington Ave., Bronx, N.Y.
Charles E. Keniston, '26; August 18, 1982; 23 Harbour Hill Run, South Yarmouth, Mass.
Adon N. Smith III, '26; June 22, 1982; 2329 Pender Pl., Charlotte, N.C.
Willard E. Vaughan, '26; June 4, 1982; 304 E Marshall St. Apt. 927, Westchester, Penn.
Marcus P. Robbins, '27; April 1982; PO Box 213, Weston, Vt.
Elmer J. Deane, '28; July 19, 1981; 407 Goodmans Crossing, Clark, N.J.
Jerome W. Stafford, '28; June 18, 1981; 28181 Westover Way, Sun City, Calif.
Arthur H. Dickinson, '30; 1976; 8015 SE 31 Ave., Portland, Ore.
Saul Sigel, '30; April 30, 1982; 300 No. Adams St., Manchester, N.H.
Carl W. Orleman, '31; September 21, 1982; 9600 North Miami Ave., Miami, Fla.
Joseph R. Brennan, '32; November 5, 1982; 1200 S Washington St. #324E, Alexandria, Va.
Arthur Miller, '34; November 8, 1982; 91 Walnut Hill Rd., Chestnut Hill, Mass.
Victor G. Mooradian, '34; October 23, 1982; 11 Manor Hill Rd., Summit, N.J.
John H. Colby, '35; November 27, 1982; Rt #1 Box 91A, Islamorada, Fla.
Raymond A. Dreselly, '37; October 27, 1982; 10727 Meadow Lake, Houston, Tex.
Curt E. Hoerig, '38; October 7, 1980; 9564 Beverly Place, Wauwatosa, Wisc.
Daniel N. Phillips, '38; February 20, 1982.
Donald G. Robbins, Jr., '38; October 11, 1982; 175 Old Post Rd., Fairfield, Conn.
Loring W. Schutz, '38; September 27, 1982; 251 Kaalawai Pl., Honolulu, Hawaii.
Hugh F. Kennison, '39; October 8, 1982; 111 Avon Dr., Essex Fells, N.J.
Paul K. Bunke, '40; September 13, 1982; Straws Point, Rye, N.H.
David M. Johnstone, '40; October 23, 1982; PO Box 388, Salt Acres, Stonington, Conn.
George T. Pew, '40; August 2, 1982; 231 Cheswold Hill Rd., Haverford, Penn.
Frank D. Pillatt, Jr., '40; October 21, 1982; 1455 Orchard Rd., Westfield, N.J.
John J. Herguth, '41; September 18, 1982; 729 1 St., Westfield, N.J.
Edward G. Spinks, '41; May 25, 1982; 718 East Northview Ave., Indianapolis, Ind.
John Reed, '43; March 6, 1982; 100 Lexington St. #A9, Belmont, Mass.
Walter F. Cole, Jr., '47; December 22, 1979; Nauyoung Rd., PO Box 610A, Masons Island, Mystic, Conn.
Irving A. Breger, '50; October 13, 1982; 212 Hillsboro Dr., Silver Spring, Md.
Dean A. Powers, '51; November 11, 1982; 26 Riverdale Circle, Concord, Mass.
John J. Magarian, '52; August 21, 1982; 7 Middlebury Ln., Los Altos, Calif.
Vicent J. Roggeveen, '53; September 25, 1981; PO Box 922, Los Gatos, Calif.
Themistocles Floridis, '54; September 30, 1982; 1405 Locust Ave., Blacksburg, Va.
Robert E. Workman, '58; November 18, 1982; 2885 Pioneer Trail, Hudson, Ohio.
Harold F. Stedman, '60; February 27, 1982; 23 Avalon Rd., West Roxbury, Mass.
Alan L. Bloom, '65; October 1976; Locus Creative Leisure Society, PO Box 653, Sooke, Canada
Graeme M. Aylward, '66; August 27, 1982.
Josef F. Graczyk, '68; January 29, 1982; 105 Poplar Ave., Hackensack, N.J.
Cary P. Silverston, '77; September 2, 1982; 79-22 257 St., Floral Park, N.Y.
Gregory W. Sims, '78; July 24, 1982; 479 South St., Murray Hill, N.J.

Courses

I

Civil Engineering

Joseph E. Soussou, S.M.'70, and **Jacques N. Sultan,** Ph.D.'69 both former members of the department at M.I.T., are partners in the development of 40 homes on a 45-acre tract in Milton, Mass., to be known as Emerson Woods. The tract, to be developed to emphasize woodland conservation, is named for William Emerson, whose son was a member of the M.I.T. Architecture Department from 1919 to 1939.

"The challenges and opportunties facing the professional civil engineer and the construction industry over the next few decades will require new knowledge, analytic techniques, and technology—a statement of need which has led to development of a new Center for Construction Research and Education in the Civil Engineering Department at M.I.T. The goal is new partnership with the construction industry in both research and education; there will be symposia, seminars, short courses, a program for senior construction industry executives, and advanced-degree programs. Professor **Fred Moavenzadeh** is director, and **Charles H. Helliwell,** S.M.'63, is deputy director.

Paul H. Robbins, S.M.'36, was installed as president of the engineering profession's national engineering honor society, Tau Beta Pi, at its 77th annual convention at the University of Idaho. . . . **Roger E.A. Arndt,** Ph.D.'67, professor and director of the St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, has been elected to the grade of fellow in the American Society of Mechanical Engineers. . . . **Jerome B. York,** S.M.'61, has been appointed managing director of Chrysler de Mexico S.A., with responsibilty of the firm's overall operation.

Allen F. Grun, S.M.'58, writes, "I have been head of the Engineering Department at the United States Military Academy (West Point) for the last two years." . . . **James V. Hamel,** S.M.'66, reports that his firm Hamel Geotechnical Consultants, Monroeville, Penn., participated in a technical delegation on engineering geology and geotechnical engineering to the People's Republic of China. He visited engineering projects in several Chinese cities and lectured on "Foundation Sliding Stability Evaluations for Gravity Dams."

II

Mechanical Engineering

Five members of the M.I.T. community were honored at the 1982 Winter Annual Meeting of ASME:

☐ **Sir William R. Hawthorne,** Sc.D.'39, master of Churchill College, Cambridge, England, and senior lecturer in the M.I.T. Department of Aeronautics and Astronautics, received the rank of honorary member in ASME.

☐ Professors **Nam P. Suh,** '59, and **Bruce M. Kramer,** '72, both members of the M.I.T. faculty, received the Blackall Machine Tool and Gage Award for their joint paper on "Tool Wear by Solution."

☐ Professor **Iain Finnie,** SC.D.'53, chairman of the Department of Mechanical Engineering at the University of California, Berkeley, received the Nadai Award for "distinguished contributions to the field of engineering materials."

☐ **Hans M. Mark,** Ph.D.'54, deputy administrator of NASA, was honored as the ASME's Thurston Lecturer at the meeting.

Professor **Thomas B. Sheridan,** Sc.D.'59, head of the M.I.T. Man-Machine Systems Laboratory, was one of four instructors in a short course in "Robotics: Research and Business Opportunities" staged by IEEE late last year. Satellite transmission was used to present the course simultaneously in 15 locations in 10 states.

Wai K. Cheng, Ph.D.'78, has been named the Carl Richard Soderberg Assistant Professor in Power Engineering at M.I.T. A member of the faculty since 1980, Professor Cheng is a specialist in internal combustion and gas turbine engines in the Sloan Automotive Laboratory.

Ioannis V. Yannas, S.M.'59, who is professor of polymer science and engineering in the department at M.I.T., was nominated (with Dr. John F. Burke, visiting professor of experimental surgery in the Department of Nutrition and Food Science) for a 1982 Cutty Sark Science Award for the development of a two-layered artificial skin for the treatment of burns.

Roger L. McCarthy, Ph.D.'77, has become president of Failure Analysis Associates with headquarters in Palo Alto, Calif. . . . **Commander Eric G. Newberg, Jr.,** S.M.'46, U.S.N. (retired) of the Narragansett Bay Chapter was recently appointed Rhode Island state commander of the Military Order of the World Wars. He will also be a member of the National Chapter Development Committee and the Legislative Committee. . . . **Philippe Villers,** S.M.'60, is in the process of establishing a new foundation to deal exclusively with problems of aging and the elderly. The foundation—to be called the Villers Foundation—will be designed to reshape public attitudes and policies concerning the elderly and "is going to change how old people are treated in this country and the quality of their lives," said Laura Monroe, a staff attorney at the Greater Boston Elderly Legal Services.

IV

Architecture

Freda Lee Nason, '77, was an unsuccessful candidate for state treasurer in the Massachusetts elections on November 2, 1982. Running on the Libertarian ticket, Ms. Nason opposed campaign finance laws and the state lottery; she said government should legalize victimless crimes and eliminate all patronage and "redundant positions."

Toufic E. Kadri, M.Arch.'82, writes that he owns a consulting firm for architecture and planning in London, England, which deals mainly with the Middle East. . . . **Robert S. Allan,** M.Arch.'55, writes, "I have continued to operate and expand our architectural, planning, and engineering firm, concentrating on commercial and institutional work. In 1981 we also formed a management consulting firm which operates as a companion firm to our architectural service. This enables us to greatly expand the scope of the services we now provide for our clients. We have moved into larger space but are still located in Dallas, Tex. Correspondence and visits from former classmates and staff are encouraged."

S. Ira Grossman, M.Arch.'70, writes, "I am relocating to Los Angeles to run the new California office for A. Epstein and Sons, Inc., architects and engineers. We provide consulting services over a wide area but specialize in industrial facilities.

George L. Thompson, '37, of Tustin, Calif., passed away on April 17, 1981; no details are available.

V

Chemistry

John C. Sheehan, professor emeritus of organic chemistry at M.I.T. who pioneered in the synthesis of penicillin, was honored late last year by a day-long symposium at the Univeristy of Cincinnati. Among the lectures: "John C. Sheehan: Manipulator of Molecules Both Large and Small" by Robert W. Perry, president of the American Chemical Society; "Penicillins and Peptides: Modern Chemical Miracles—a Tribute to John C. Sheehan," by Professor Murray Goodman of the University of California at San Diego; and "Judging Science—the Gray Area," by Professor Sheehan himself.

Philip A. Selwyn, Ph.D.'70, an executive with the Department of the Navy, Washington, D.C., has been appointed a Presidential Exchange Executive for 1982-83 program year. He will be stationed in Minneapolis, Minn., with the Honeywell Corp., helping to establish a better understanding between business and government. He will serve as assistant to the vice-president for science and technology. . . . **Brian D. Andresen,** Ph.D.'74, reports that he is currently associate professor of pharmacology at the Ohio State University College of Medicine. In August 1982 he was awarded tenure and has set up the National Reye's Syndrome Research Laboratory and initiated screening for birth defects and childhood illness using computer-guided gas chromotography. A great deal of his research effort has been on the harmful effects of direct and indirect nicotine exposure to the fetus of pregnant women.

The following graduates participated in a fall Alumni Fund upgrading telethon: **B. David Green,** Ph.D'76; **Joel Silver,** Ph.D.'76; and Telethon Coordinator **Jeffrey Steinfield,** '62.

Donald B. Sparrow, S.M.'49, writes, "I have retired and moved to Cape Cod, Mass., doing some consulting work. (Doesn't everyone?) Otherwise—landscaping our mini-estate, gardening, doing some writing for the *Cape Codder,* fishing, boating, planning expansion of house, etc."

. . . **Max G. Sherer,** S.M.'43, reports, "My son David is in his third year at Boston University Medical School; my son Daniel is in his second year at Yale University; my daughter Devora is an artist in residence in Rome, Italy; and I am still practicing medicine in the Washington, D.C. area." . . . **Steven J. Gould,** Ph.D.'70, is currently associate professor of chemistry at Oregon State University, Corvallis.

Manly M. Windsor, Ph.D.'32, reports that he is a retired chemist. . . . **Gerald B. Kastings,** Ph.D.'80, since graduation has been a staff chemist with Procter & Gamble Co., Miami Valley Laboratories.

Lynn J. Taylor, Ph.D.'63, of Worthington, Ohio, was killed in a traffic accident on August 7, 1982. . . . **Henry H. Blau,** S.M.'20, of Wayland, Mass., passed away on February 11, 1980; no details are available.

VI

Electrical Engineering and Computer Science

Dean Gerald L. Wilson, '61, is one of 20 directors of a new Massachusetts Technology Park Corp., whose first project is a $40-million Massachusetts Microelectronics Center for training in the design, fabrication, and testing of semiconductor devices.

Pierre A. Humblet, Ph.D.'78, associate professor of electrical engineering at M.I.T., now holds the Nippon Electric Co. Career Development Professorship of Computers and Communications. As holder of the chair he'll visit Japan and be responsible for hosting Japanese visitors to M.I.T., all in the interest of promoting technical and cultural exchange between two countries.

William W. Swartout, Ph.D.'81, is a member of the Information Sciences Institute at the University of Southern California, continuing research on the problem which was his doctorate thesis at M.I.T.: how to make a give its answer and explain how that answer was obtained—"a way of building into the computer the ability to respond to your cross-examination of its recommendations," he explains.

From an M.I.T. office to Shuttle 5 is a long flight—completed successfully by **William B. Lenoir,** '61, who was assistant professor in the Department of Electrical Engineering and Computer Science for two years starting in 1965. As a NASA scientist-astronaut, Dr. Lenoir was to have gone on a "spacewalk" to release a pair of communications satellites and perform other manual tasks during the Shuttle 5 flight, but space sickness forced cancellation of that part of the mission.

Michael Brady, senior research scientist in the Artificial Intelligence Laboratory, is co-editor (with Professor Richard P. Paul of Purdue) of a new quarterly journal of *Robotics Research*. The M.I.T. Press, publisher, describes it as "the first and only scholarly, peer-reviewed journal of robotics published in the U.S."

Jerry Abel, '60, and **David Whipple,** S.M.'48, participated in the M.I.T. Alumni Fund departmental upgrading telethon. . . . **Paul A. Basore,** S.M.'81, has joined the faculty in the Department of Electrical Engineering at Iowa State University, where he is active in establishing a new interdisciplinary microelectronics research center. . . . **John T. Newman,** S.M.'47, writes, "After nine years as technical director of U.S. Army Concepts Analysis Agency (operations research), I am currently deputy for systems management of the U.S. Army Materiel Command." . . . **Richard W. Boberg,** S.M.'73, was systems engineer at Intel Corp., developing the multibus for 8- and 16-bit microprocessors (1974-1978); he is currently a founder and president of Microbar Systems, Inc., Palo Alto, Calif.

Terrence P. McGarty, Ph.D.'71, is currently vice-president of Warner Amex Cable Communications, responsible for the development of interactive home transaction systems in New York City. . . . **David S. Prerau,** Ph.D.'70, is presently senior staff member at GTE Laboratories, Inc., Waltham, Mass. . . . **Emanuel Schnall,** S.M.'55, writes, "As principal electrical engineer at Hydro Products, San Diego, Calif., now a part of Honeywell, I am developing power control systems and electronic drive units for remote-controlled underwater inspection and work vehicles—the undersea robots of the energy industry." . . . **Jon Doyle,** Ph.D.'80, is presently on the faculty of the Computer Science Department at Carnegie-Mellon Unversity. . . . **John L. Jones,** S.M.'54, former vice-president/management, of Norfolk Southern Corp., Roanoke, Va., is currently its vice-president/administration.. . . **Richard C. Norris,** Sc.D.'62, a senior consultant in operations research at Arthur D. Little, Inc., Cambridge, Mass., is leading a study of an electronic data interchange (EDI) that allows computer-to-computer communications among manufacturers, brokers, and distributors in the grocery industry.

Earle W. DuBois, S.M.'50, has been appointed vice-president and general manager of Westinghouse Electric Corp.'s Combustion Turbine Systems Division, Concordville, Penn., responsible for the design, sale, and installation of combustion turbines for industrial and utility markets worldwide. . . . **John P. Liebesney,** S.M.'74, reports that he is currently product manager for patient monitoring central stations at Hewlett-Packard Medical Products, Waltham, Mass.; he is married to **Claudia Burroughs Liebesny** (Course XV, '80), and their first child, Katherine Valerie, was born on September 29, 1982.

X

Chemical Engineering

Frederick A. Putnam, who joined the department at M.I.T. as assistant professor in 1976, has resigned to form Laboratory Technologies Corp., of which he serves as president, chief executive officer, and primary stockholder. The company will develop and market microprocessor-based computer systems for scientific research—an extension of the work in which Dr. Putnam was engaged at M.I.T.

Five members of the M.I.T. community were among those honored at the Los Angeles meeting of AIChE late last fall:

☐ Professor **Lawrence B. Evans** received the Computing in Chemical Engineering Award, given "to recognize innovative use of computing and system technology in chemical engineering practice."

☐ **Ralph Landau,** Ph.D.'41, former chairman of the Halcon SD Group, Inc., who is now owner of Listowel, Inc., was honored with the 1982 Founders Award, given annually to recognize outstanding contributions to the development of the chemical engineering profession.

☐ **Robert B. MacMullin,** '19, associate emeritus of the Niagara Falls, N.Y., consulting firm that bears his name, received the 1982 Award in Chemical Engineering Practice for "pioneering efforts in the development and application of electrochemical technology."

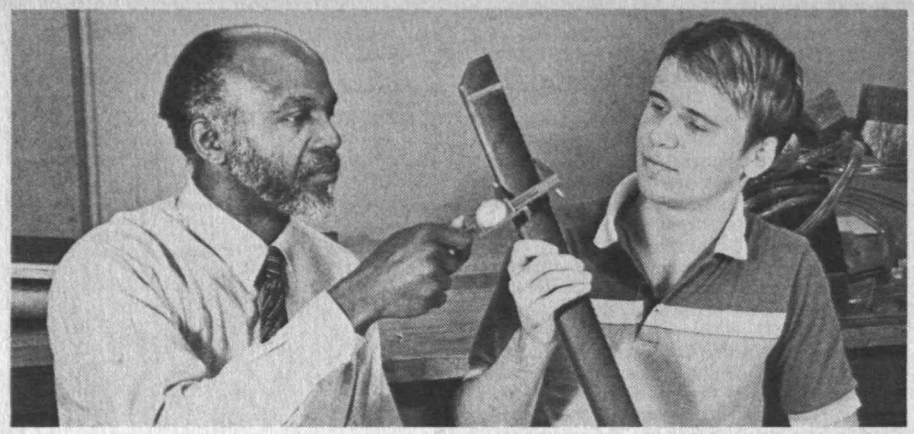
☐ Professor **Edward W. Merrill,** Sc.D.'47, received the 1982 Alpha Chi Sigma Award for contributions to the advancement of biomedical engineering.

☐ **Alan S. Michaels,** '44, adjunct professor, was recipient of the 1982 Materials and Engineering Sciences Division Award for research and application of membrane and controlled-release technology.

Two new attitudes gaining a foothold in the U.S. represent a major transition in America's attitude toward energy, says **Jan W. Mares,** S.M.'60, acting under secretary of the Department of Energy:

☐ Government prioritizing is not necessary; "our strength lies in free and open market competition" between energy sources.

☐ Forty-year-old technologies are obsolete; a new generation of energy systems is now



Attacking helicopter blade noise. International cooperation stimulated by Professor Wesley L. Harris (left) has brought to M.I.T. this model of a unique helicopter blade designed by Aerospatiale, Paris, with a swept-back tip and subtle twist. Using the model as a pattern, Mark Drela (right), a graduate student in the department, will build a set of blades for wind tunnel testing.

emerging—more efficient, more economical, and more environmentally acceptable.

We now recognize, Dr. Mares told the 10th Illinois Energy Conference late last year, that we need not "jump from one energy crisis to the next. We are not energy-secure yet," he said, "but we have the time to proceed along a pathway clearly defined by scientific understanding, economic realities, and social choices."

Philip M. Grover, S.M.'57, is currently vice-president and general manager of the Coke Division at the Alabama By-Products Corp., Birmingham, responsible for all coke and coal chemicals operations and sales and for quality control and environmental resources functions throughout the company. . . . **Manfred Gans,** S.M.'51, senior vice-president of technology with the Scientific Design Co., a division of Halcon SD Group, Inc., New York City, has been elevated to the rank of Fellow by the American Institute of Chemical Engineers. He has been honored for his work in commercialization, design development, and start-up of petrochemical plants and is author of a text *The Chemical Plant*, and several technical papers. Also elevated to the rank of a Fellow by the AIChE is **Edgar B. Gutoff,** Sc.D.'52, senior principal engineer with Polaroid Corp., Waltham, Mass. He was honored for his contributions to the development of photographic emulsions as author of 19 technical papers and three patents.

Jose M. Torradas, Ph.D.'82, is currently a senior engineer at Erco Petroleum Services, Houston, Tex. . . . **Howard Klee,** Sc.D.'72, was recently appointed senior engineer in the Process Design Department of Amoco Oil, Chicago. . . . **Michael Jon Kell,** S.M.'72,recently received U.S. and foreign patents for cellulose acetate hollow fiber and for a method for making it." He is completing his M.D./Ph.D. program in membrane biopysics at Emory University. . . . **David E. Reid,** S.M.'38, reports, "I am adjunct professor of thermodynamics at Jacksonville University. After 40 years in industry, I am applying the wisdom of Professor Harold Weber. I might add that after this lag of time it's not easy to do." . . . **Marguerite Farnsworth,** '46, was a caller in the M.I.T. Alumni Fund departmental upgrading telethon.

Sergio C. Trindade, Ph.D.'73, writes, "After almost seven years as technology development director of Promon, a leading Brasilian architecture and engineering firm, I started an independent consulting practice in energy analysis and technology development based in Rio de Janeiro and am serving international clients and organizations worldwide." . . . *Bruce R. Duggar,* S.M.'62, is currently a director of Mid-American Holding Co., Baton Rouge, La. . . . **Nelson T. Bogart, Jr.,** S.M.'39, writes, "Have kept busy during my four years in retirement from Standard Oil Co. of California, taking care of our three acres and home in Alberton and cabin on a lake in the Sierras, where we enjoy sailing, swimming, and water-skiing, especially with the grandchildren. Going to Africa in February." . . . **Myron W. Belaga,** S.M.'52, reports that he became president in January 1982 of the GHR Companies, Inc., an oil and gas company with headquarters in Good Hope, La. . . . **Curtis G. Gerald,** Sc.D.'41, has been named to the newly created position of associate vice-president for information systems at California Polytechnic State University, responsible for the university's Computer Center, Audiovisual Department, Computer Aided Productivity Laboratory, and telephone and data communications. . . . **Burton B. Crocker,** S.M.'47, is currently a Monsanto Distinguished Fellow in the Engineering and Technology Section of the Corporate Engineering Department, St. Louis, Mo. He is an expert in the technology of gas-solid separation and distribution and nationally known for his work in air pollution control and education. He recently received the 1981 Environmental Division Award from the American Institute of Chemical Engineers for his contributions to the preservation and improvement of the environment.

Ronald T. Kurnik, Sc.D.'81, reports that he has joined Phasex Corp., as director of research. Phasex is a high-technology company specializing in applications of supercritical fluid technology to difficult material separations problems. He was previously employed by General Electric Research Laboratory, Schenectady, N.Y.

F. Charles Moesel, Sc.D.'40, of Allentown, Penn., passed away on May 26, 1982. Until his retirement in 1966 he was project engineer for the Atomic Energy Commission, Washington, D.C. Prior to this he was professor of chemical engineering at the University of Michigan and worked for the U.S. Navy in Europe. . . . **John D. Ryan,** S.M.'51, project manager at Fluor Engineering & Constructors, Inc., Houston, Tex., passed away on February 19, 1982. . . . **Donald K. Duffey,** S.M.'41, of Wilmington, Del., passed away on July 22, 1982; no details are available.

XII

Earth and Planetary Sciences

Professor Emeritus Robert Shrock has recently published his second in the two-volume series on the history of M.I.T.'s Geology Department (M.I.T. Press). Volume I—*Geology at M.I.T.: 1865-1965 (Faculty and Supporting Staff)*—encompasses biographical sketches of the first 53 professors in the department along with the history of development of the Institute, faculty, and curriculum, and contributions by the support staff. Volume II—*Geology at M.I.T.: 1865-1965 (Departmental Operations and Products)*—describes departmental operations and products: instruction, research, and graduates. Included are discussions of the M.I.T. time capsule, facilities for teaching and research, financing, women in geology, and the development of geochemistry, to list but a few. Included is a listing of those who received geology degrees, titles of their theses, and names of the professors who supervised the theses, and listings and brief abstracts of books published by Course XII graduates.

Grant Buma, S.M.'70, reports that he is a consulting geological engineer in groundwater problems for Niagara Mohawk Power Co.; general manager of Amigo Mining Co., a gold mine near Craig, Colo.; and consulting engineer in several oil projects.

Irving A. Breger, Ph.D.'50, a research chemist for the U.S. Geological Survey who was internationally known as an authority in geochemistry, passed away October 13, 1982. He retired in 1980 but continued working at the USGS on a part-time basis. Some of his former positions included professor of chemistry and earth sciences at American University, visiting professor of chemistry and geology at the University of Maryland, consultant for the Los Alamos Scientific Laboratory, and adviser for the Institute of Geochemistry at the Central University of Venezuela. He wrote more than 100 scientific reports and papers and was editor-in-chief of the journal *Organic Chemistry*.

XIII

Ocean Engineering

The 1982 Distinguished Technical Achievement Award of the IEEE Council on Ocean Engineering was given to Professor **Ira Dyer,** '49, at the Oceans 82 Conference late last year in Washington.

William N. Price, S.M.'41, reports that he has retired for the second time and is now working full-time, *pro bono*, for severely physically handicapped, mentally alert adults at Independent Living for the Handicapped, Washington, D.C. . . . **Robert P. Dickenson,** S.M.'69, is currently serving as chief of the Shipbuilding Branch at Coast Guard Headquarters, Washington, D.C.

Word has recently been received that **James A. Griswold,** '49, associate director of engineering at the Grand Central Rocket Co., Redlands, Calif., passed away on April 8, 1973.

XV

Management

Thinking that policy issues concerning U.S. health care will become increasingly debated and critical during the next decade, Professors **Edward B. Roberts,** '57, and **Stan N. Finkelstein,** '71, have won faculty approval for a five-year trial of a Ph.D. program in health policy and management. The goal, they said, will be to educate "a new generation of academic leaders" who will influence health care policymaking through both teaching and research. There will be ten students a year during the first five years in a curriculum including management, behavioral science, political science, economics, mathematics, and biological science. The program will be conducted in the Whitaker College, where Professor Roberts heads the Division of Health Policy and Management; Professor Finkelstein is director of a new Laboratory for Health Care Studies, charged

with implementing M.I.T.'s commitment to research and teaching in health economics and policy. Funds from the Henry J. Kaiser Family Foundation will be available for student support.

Dorothy Eleanor Westney, who arrived at M.I.T. to be assistant professor in international management last fall, is now the first Mitsubishi Career Development Professor. The chair is intended for junior faculty with a strong interest in comparative management who will devote at least a portion of their research and teaching to better understanding Japanese culture and institutions. Dr. Westney, who is fluent in Japanese, holds degrees in sociology from the University of Toronto and Princeton and for four years held a joint appointment in sociology and mangement at Yale.

David L. Bodde, S.M.'73, is currently assistant director, Congressional Budget Office. . . . **William M. Nuckols,** S.M.'64, has been named vice-president for business planning and analysis at the Penn Central Corp., New York City. . . . **Bernard J. Jourdan,** S.M.'70, writes, "I am back in the states as executive vice-president for the Campagnie Generale des Cieux U.S. Group. I moved to Philadelphia, Penn., from Paris in January 1982. I married in late 1981 and my wife is expecting a baby." . . . **Gordon C. Shaw,** DS.M.'60, professor of administrative studies at York University, Canada, has just completed a two-year study to forecast the number of Canadian-registered dry-bulk vessels required to serve Great Lakes cargoes in 1990. The final report has been published by the University of Toronto/York University Joint Program in Transportation.

The following graduates participated in the M.I.T. Alumni Fund upgrading telethon: **Samuel Appleton,** S.M.'57; **Carol Bratley**; **Peter Condakes,** S.M.'80; **Stephen Hall,** S.M.'62; **Howard Hillman,** S.M.'60; **Walter Lehmann,** S.M.'75; **Howard Miller,** S.M.'63 (coordinator and top caller); **Constance Stubbs,** S.M.'79; and **Thomas Thompson,** S.M.'57.

Sloan Fellows

Donald H. White, S.M.'70, senior vice-president at Hughes Aircraft Co., Culver City, Calif., has been named a director of the company. . . . **Hugh E. Witt,** S.M.'57, vice-president, government liaison, United Technologies Corp., has been elected vice-chairman of Aerospace Industries Association of America, Inc., Washington, D.C. . . . **Claudia B. Liebesny,** S.M.'80, is currently product manager—fused and sintered specialty products at the Norton Co., Worcester, Mass.

Jere Drummond, S.M.'77, is currently vice-president of Southern Bell Telephone & Telegraph Co., Charoltte, N.C. . . . **C. Clement Patton,** '77, is currently vice-president of Southern Bell Telephone & Telegraph Co., Atlanta, Ga.

Senior Executives

Alexander M. Williams, '63, former president—U.S. Division of the Campbell Soup Co., Camden, N.J., is currently president—International Division. . . . **Joseph A. Baute,** '64, chairman and chief executive officer of the Markem Corp., has recently been named a director of Houghton Mifflin Co., Boston, Mass.

Julian Hartwell, '67, of Cohasset, Mass., and a long-time executive with New England Telephone Co., passed away on September 25, 1982.

XVI

Aeronautics and Astronautics

What happened to the Navy's fleet defense missile system known as Talos? It was the first ramjet-powered guided missile, first conceived in 1945 and delivered to the Navy in 1955. But it was never used to its full capability, say two analysts—Rear Admiral **Wayne E. Meyer,** '47, and Captain (Ret.) **Richard W. Anderson,** S.M.'60—in the spring of 1982 issue of John Hopkins Physics Laboratory's *Technical Digest.* Talos' electronics became obsolete before their time, maintenance was high, and detection systems were inadequate to locate targets at a distance large enough for Talos to be fully effective, write authors Meyer and Anderson. Among the reasons is that Talos never had an at-sea development site except on operational ships of the fleet; White Sands Missile Range was the only test facility that could handle Talos.

Professor Emeritus **C. Stark Draper,** '26, received the Medal of the City of Paris as guest of honor at the 33rd Congress of the International Astronautics Federation in Paris late last summer. During the Congress "Doc" Draper resigned his post as president of the IAF's Academy of Astronautics after 19 years of service. Preceding his engagements in Paris, "Doc" had attended the UNISPACE '82 Conference in Vienna and the History of Astronautics and Rocketry Conference in Moscow, the latter to celebrate the 25th anniversary of Cosmonaut Yuri Gagarin's first manned spaceflight. "Doc" was joined in Paris by **Janet B. Jones-Oliveria,** a graduate student in the department at M.I.T., who received the IAF's Edmond A. Brun Medal for her paper on the design of an environmental research facility for low earth orbit.

Sir **William R. Hawthorne,** Sc.D.'39, master of Churchill College, Oxford, who is senior lecturer at M.I.T., delivered the Calvin W. Rice Lecture at the 1982 winter meeting of the American Society of Mechanical Engineers and at the same meeting was designated an honorary member of ASME. The Rice Lecture topic: "World Energy versus the Environment—Conflict or Compromise."

James A. Martin, S.M.'69, has recently completed (February 1982) his D.Sc. degree from George Washington University. . . . **Leslie M. (Bud) Boring,** S.M.'64, reports, "Not too much in the way of news this past year, although the construction and engineering contractor banking business in France has gone well, the change in government notwithstanding, and our two children (girl 2 and boy 6) continue to grow marvelously. On the avocation front, have made good progress with my painting, which I started at evening classes at the Musuem of Fine Arts while still at M.I.T. (now beginning to be decades ago!). I was accepted for exhibition at the Grand Palais in Paris for both the Salon d'Automore and Salon des Artistes Francais and even won a medal in our hometown exhibition, the Prix de la Ville de Croissy-sur-Seine! Have been contacted by several galleries, although their initial demonstration of enthusiasm drops to zero when they learn I'm a banker and do not paint full time. It seems volume of productoin is what ultimately counts. Anyway, it's a lot of fun and doubly interesting as we live within 20 minutes' walk of several scenes painted by the Impressionists."

James Harrill, S.M.'64; **Gaylord MacCartney,** S.M.'53; and **Robert Stern,** Sc.D.'63, participated in the M.I.T. Alumni Fund fall upgrading telethon.

William B. Abbott III, S.M.'61, reports that he has retired from the U.S. Navy after 30 years of service. For the past 19 years he served in the Strategic Systems Project Office where he was Navy manager of the Polaris, Poseidon, and Trident submarine-launched ballistic missile programs.

XVII

Political Science

A new curriculum leading to a master's degree in political science and public policy has been approved by the faculty, and the first students will enter next fall. The program differs from the regular master's program in political science in its emphasis on policy studies in one of four fields: defense and arms control; science, technology, and public policy; communications; and international development. Mid-career professionals as well as recent bachelor's graduates are welcome as applicants; they will finish the program in one to two years, depending on preparation, and will be qualified for further studies toward the Ph.D. and for positions in government, business, and nonprofit institutions. Professor **Donald L. M. Blackmer** assured the faculty, that the department is "committed to the training of policy analysts with a broad outlook. Technical, analytical skills are important," he said, "but we believe that policy analysts must also have a larger understanding of what they are doing—of long- as well as short-term consequences of public intervention, of unintended as well as intended consequences, and of wider as well as narrower effects of policies."

XVIII

Mathematics

Professor **Daniel M. Kan,** a member of the M.I.T. faculty since 1959, has been honored by election to the Royal Netherlands Academy of Arts and Sciences; a native of Holland, Professor Kan's bachelor's and master's degrees are from the University of Amsterdam.

Jerry Grossman, Ph.D.'74, reports that he is currently associate professor of mathematical sciences at Oakland University, Rochester, Mich., and assistant department chairman. He was married to Suzanne Zeitman on August 15,, 1982. . . . **Margaret Freeman,** S.M.'34, was a caller in the M.I.T. Alumni Fund fall upgrading telethon.

XIX

Meteorology

George F. Collins, S.M.'48, has joined the Environmental Resource Planning Division of Charles T. Main, Inc., Boston, Mass., as head of air sciences. . . . **Ryland Y. Bailey,** '52, is currently senior engineer of the State Corporation Commission of Virginia and a member of the Methodist Church, Richmond.

XXI

Humanities

Carl Kaysen, David W. Skinner Professor of Political Economy who is director of the Program in Science, Technology, and Society, is a member of a committee of the American Academy of Arts and Sciences to oversee the academy's new association with the International Institute for Applied Systems Analysis, near Vienna. American support for IIASA had previously been organized through the National Academy of Sciences in Washington, but political pressure stemming from White House concern about security and possible technology transfer to the East caused NAS to withdraw.

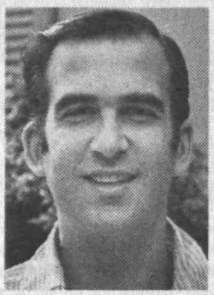
Science, Technology, and Human Values, a quarterly edited by **Marcel La Follette** in the Program in Science, Technology, and Society and cosponsored by Harvard's Kennedy School of Government, is now being published by John Wiley and Sons, Inc., New York; it has previously been in the periodicals group of the M.I.T. Press.

Technology and Policy Program

Barbara Herrmann, S.M.'81, is currently vice-president of Consulting Resources Corp., a management consulting firm which specializes in serving chemical process industries. Her firm has recently been recognized nationally for its work in commodity and specialty chemical markets. . . . **Tariq Mahmood,** S.M.'80, has accepted a new position with the Power Rates Section of the Department of Public Service, Albany, N.Y.—Professor Richard de Neufville, '60, Chairman, Room 1-138, M.I.T., Cambridge, MA 02139.

Puzzle Corner
Allan J. Gottlieb

Dropping a Rock in Borneo

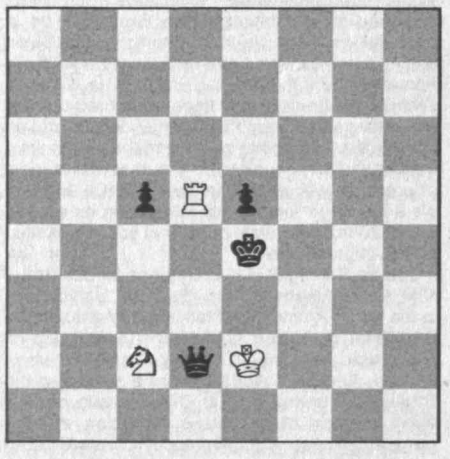


Allan J. Gottlieb, '67, is at the Courant Institute of Mathematical Sciences, New York University. He studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y., 10012.

Not very much to report this month. I am very busy helping raise our son David and managing a research group in "parallel processing" (using many cooperating computers to solve large problems much faster than is possible with a single machine). I find both parenthood and computers to be extremely interesting and rewarding; I just wish every day were a little longer so I could spend more time on each.

Problems

F/M 1 Our first problem for this month is from Bob Kimble and Jacques Labelle, who ask that White mate in three:



F/M 2 Next we have a geometry problem from Greg Huber: Let T be the torus obtained by rotating the circle $(x - 2) + y = 1$ in the xy-plane about the y-axis. Let P be a plane tangent to the torus T at the point (0, 0, 1). Find the volume and surface area of the small region obtained by slicing T with P.

F/M 3 Norman Wickstrand wants you to solve the simultaneous equations:

$x^6y = (y^2 + 1)x^3$
$y^6x = 9(x^2 + 1)y^3$

F/M 4 John Prussing adds a new wrinkle to an old problem:
A pilot flies south over a spherical earth a distance D, flies due east a distance D, and then flies due north a distance D, arriving back at precisely the starting point. For D equal to the radius of the earth, find all solutions for the starting latitude.

F/M 5 Bruce Calder hung a vertical plumb line down the center of a one-mile-deep mine shaft somewhere in Borneo. He dropped a rock from right next to the top of the plumb line. How far from the bottom of the plumb line will the rock land if we ignore friction?

Speed Department

F/M SD 1 Smith Turner sailed a 10-by-30-foot boat into a canal lock and then threw overboard a 10-cubic-foot chest having a specific gravity of 4. What happened to the water level in the lock?

F/M SD 2 A bridge quickie from Doug Van Patter:

North:
♠ K 6
♥ K J 8 7
♦ K 5
♣ A K Q J 7

South:
♠ 10 5 4
♥ A Q 10 4
♦ 10 7
♣ 8 6 3

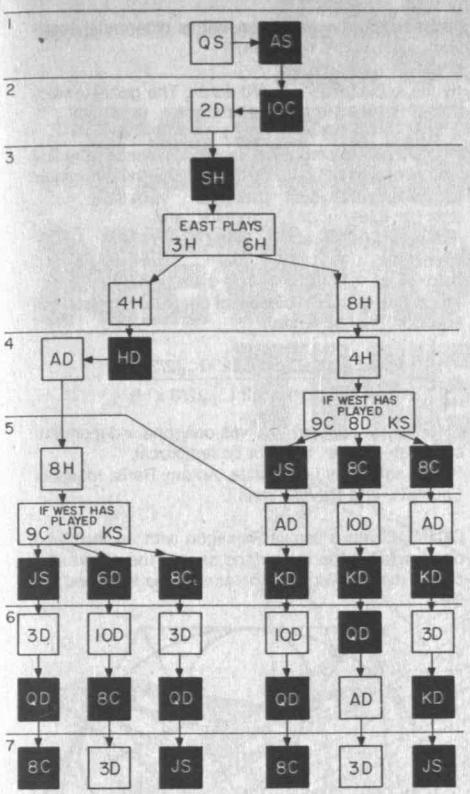
Your partner (North) opened one club and raised your one-heart bid to four. The opening lead is ♠Q. What play gives you the best chance of making your contract?

Solutions

OCT 1 South is on lead with hearts as trump and is to take all tricks against the best defense:

	♠ A J ♥ 5 ♦ K Q ♣ 10 8	
♠ K 2 ♥ — ♦ J 9 8 ♣ 9 7		♠ 4 3 ♥ 6 3 ♦ 7 ♣ 6 5
	♠ Q ♥ 8 4 ♦ A 10 3 2 ♣ —	

The following solution is from Matt BenDaniel. There are three considerations:
☐ We must pull East's trumps; this can only be done by finessing from the dummy.
☐ The bad offensive fit combined with East's diamond singleton limit transportation for the offense.
☐ West must discard the protection from his potential winners.
The basic plan, then, is to get to board in spades, finesse East once, and play another round of hearts. This will pull East's trumps and will also cause West to discard. West's discards will determine the declarer's play for the rest of the hand. The following diagram gives the details of play:



Also solved by Gian Holderness, John Woolston, Matthew Fountain, Doug Van Patter, Matt Daniel, Winslow Hartford, John Boynton, and the proposer, Emmet Duffy.

OCT 2 Solve the set of four cryptarithmetic puzzles, entitled "Seven and Twelve," created by Nobuyuki Yoshigahara.

Only Harry Hazzard was able to solve this one and even he could not find a solution to the third puzzle.

1:

13677	13788	17566	37166
47870	48280	36460	96460
47870	48280	36460	96460
47870	48280	36460	96460
157287	158628	126946	326546

2:

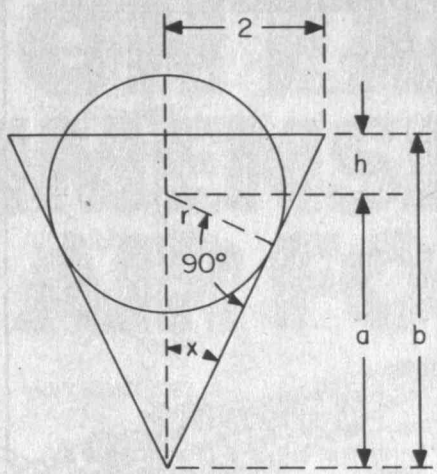
107	107	129	567	567
47570	87570	69892	27476	37476
47570	87570	69892	27476	37476
47570	87570	69892	27476	37476
47570	87570	69892	27476	37476
47570	87570	69892	27476	37476
237957	437957	349589	137947	187947

4:

8162
8162
42623
42623
42623
42623
202623
202623
592062

OCT 3 Given an ice cream cone filled with water, how large a sphere displaces the most water? Let the half angle of the cone be x, and let the radius of the base be 2.

Emmet Duffy sent us a fine solution of his own as well as a reference to a similar problem in the classic 1904 calculus book of Granville et al. Leo Harten used the well known symbolic algebra package MACSYMA and obtained an "imaginary" sphere (see the end of the following solution). Mr. Duffy writes:



Assume the sphere is tangent to the side of the cone. Let b = depth of cone and a = distance from center of sphere to bottom. Then 2/b = tan x and b = 2/tan x, or b = (2 cos x)/sin x; r/a = sin x and a = r/sin x. Then

$h = b - a = (2 \cos x - r)/\sin x$.

The volume, v, of displaced water is given by:

$v = \pi (2r^3/3 + r^2h - h^3/3)$, where h is not greater than + r nor less than − r.

$v = \pi (2r^3/3 + 2r^2 \cos x/\sin x) - r^3/\sin x - (2 \cos x - r)^3/3 \sin^3$.

$dv/dr = \pi [2r^2 + 4r\cos x/\sin x - 3r^2/\sin x - (2\cos x - r)^2(-1)/\sin^3 x]$

$dv/dr = \pi [2r^2 + 4r\cos x/\sin x - 3r^2/\sin x + (4\cos^2 x - 4r\cos x + r^2)/\sin^3 x]$

Set dv/dr to zero, clear fractions, and divide by π. Then:

$2r^2\sin^3 x + 4r\cos x\sin^2 x - 3r^2\sin^2 x + 4\cos^2 x - 4r\cos x + r^2 = 0$

Collecting terms:

$r^2(2\sin^3 x - 3\sin^3 x + 1) + r(4\cos x\sin^2 x - 4\cos x) + 4\cos^2 x = 0$.

$r^2(2\sin^3 x - 3\sin^3 x + 1) + 4r\cos x(\sin^2 x - 1) + 4(1 - \sin^2 x) = 0$.

Factoring:

$r^2(2\sin x + 1)(\sin x - 1)(\sin x - 1) + 4r\cos x(\sin x + 1)(\sin x - 1) + 4(1 + \sin x)(1 - \sin x) = 0$.

Divide by $(\sin x - 1)$:

$r^2(2\sin x + 1)(\sin x - 1) + 4r\cos x(\sin x + 1) - 4(\sin x + 1) = 0$.

Solving this using the quadratic formula yields the expressions for r shown at the bottom of this column; the desired value of r is

$r = -4\cos x/2(2\sin x + 1)(\sin x - 1) = 2\cos x/(2\sin x + 1)(1 - \sin x)$ which converts to:

$r = 2\cos x/(\sin x + 1 - 2\sin^2 x)$ or

$2\cos x/(\sin x + \cos 2x)$.

The other value of r is

$r = (-8\cos x\sin x - 4\cos x)/2(2\sin x + 1)(\sin x - 1)$.

This simplifies to $r = 2\cos x/(1 - \sin x)$, the radius of an imaginary sphere tangent to the imaginary extension of the cone and also tangent to the tip of the water level of a full glass, displacing no water.

Also solved by Winslow Hartford, Norman Wickstrand, Matthew Fountain, David Evans, Harry Zaremba, William Moody, and the proposer, Edmund Nadler.

OCT 4 Find the closed form (not infinite series) solution of $dy/dx = x - y^2$.

The following solution is from John Wrench:

The differential equation $dy/dx = x - y^2$ is a special case of Riccati's equation and is transformable to a

$r = \{-4\cos x(\sin x + 1) \pm [16\cos^2 x(\sin x + 1)^2 + 16(2\sin x + 1)(\sin^2 x - 1)]^{1/2}\}/2(2\sin x + 1)(\sin x - 1)$

$r = \{-4\cos x(\sin x + 1) \pm [16\cos^2 x(\sin x + 1)^2 - 16\cos^2 x(2\sin x + 1)]^{1/2}\}/2(2\sin x + 1)(\sin x - 1)$.

$r = [-4\cos x(\sin x + 1) \pm (16\cos^2 x\sin^2 x)^{1/2}]/2(2\sin x + 1)(\sin x - 1)$

$r = [-4\cos x(\sin x + 1) \pm 4\cos x\sin x]/2(2\sin x + 1)(\sin x - 1)$

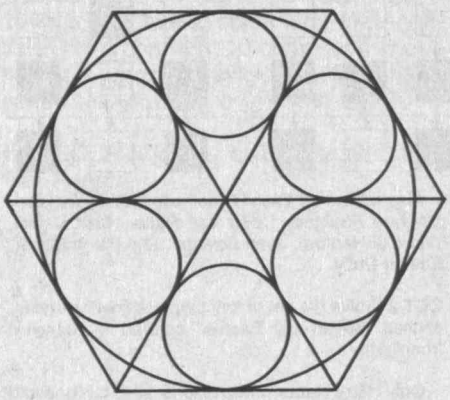
second-order linear homogeneous differential equation (called Airy's equation):
$d^2u/dx^2 - xu = 0$,
by the substitution $y = 1/u\ du/dx$. The general solution of the transformed equation is
$u = c1\ x^{.5}\ I_{1/3}(2/3\ x^{1.5}) + c2\ x^{.5}\ I_{-1/3}(2/3\ x^{1.5})$,
where the Is are modified Bessel functions of the first kind of orders 1/3 and −1/3. If we use the differential formulas
$d/dx\ [u^p\ I_p(u)] = u^p\ I_{p-1}(u)du/dx$, and
$d/dx\ [u^{-p}\ I_p(u)] = u^{-p}\ I_{p+1}(u)du/dx$,
we obtain
$du/dx = c1\ x\ I_{-2/3}(2/3\ x^{1.5}) + c2\ x\ I_{2/3}(2/3\ x^{1.5})$.
Thus, the general solution of the given differential equation may be written

$$y = \frac{c1\ x^{.5}\ I_{-2/3}(2/3\ x^{1.5}) + c2\ x^{.5}\ I_{2/3}(2/3\ x^{1.5})}{c1\ I_{1/3}(2/3\ x^{1.5}) + c2\ I_{-1/3}(2/3\ x^{1.5})}$$

Clearly, that solution involves only one independent constant—that is, c1/c2 or its reciprocal.

Also solved by Leo Harten, Antony Beris, Matthew Fountain, and David Evans.

OCT 5 Given a regular hexagon with an inscribed circle, what is the ratio of the area of the six smaller circles (see drawing) to the area of the inscribed circle?



Roger Milkman had little trouble with this one: The answer is two-thirds, assuming that the ratio desired is that of the total area of the six small circles to the area of the large one. Set the radius of the inscribed large circle at 1. Draw it vertically upward from the center; it is perpendicular to, and bisects, the top side of the hexagon. Each side of each of the equilateral triangles is therefore sec 30° (since the radius so drawn also bisects the lowest angle of its triangle). The radius of (for example) the upper left hand small circle will be perpendicular to, and bisect, any side of its triangle that it reaches. It will also bisect the opposite angle if prolonged. The radius of the small circle is thus [½ sec 30°] tan 30°, or 1/3. The ratio of the areas is 6 times the ratio of the squared radii, or 6/9, or 2/3.

Also solved by John Woolston, Emmet Duffy, David Evans, Norman Wickstrand, Winslow Hartford, Naomi Markowitz, Irl Smith, Mary Lindenberg, Matthew Fountain, Jordan Wouk, Steve Feldman, David Lukens, Phelp Meaker, and Raymond Gaillard.

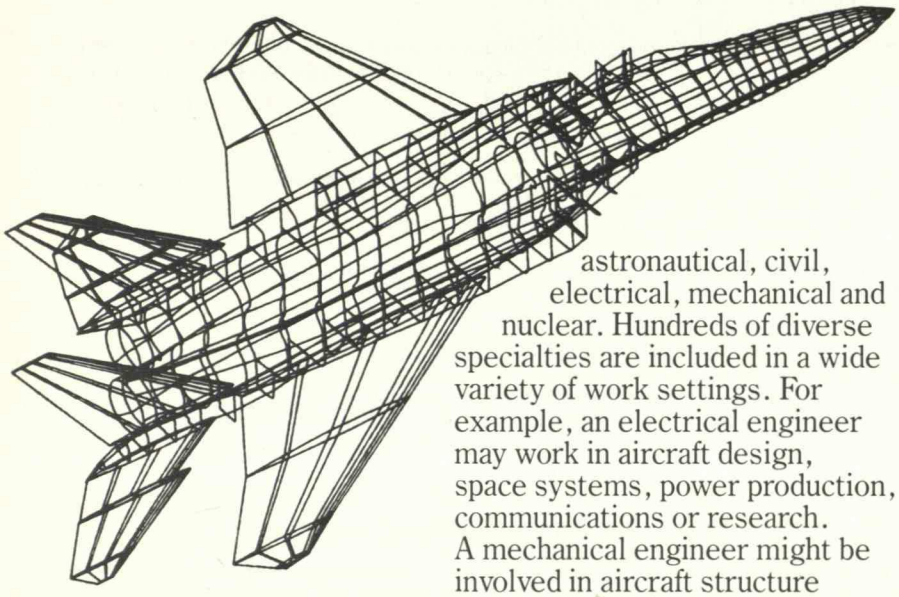
Better Late Than Never

M/A 4. Robert Kennedy has responded.
JUL 1, JUL 3, and **JUL 5.** Richard Hess has responded.
A/S 5. John Woolston has responded.
Y1982. Harry Hazard has responded.
OCT SD1. The proposer doesn't feel the problem is speedy.
OCT SD2. The proposer believes that calculating the last eight digits is more fun.

Proposers' Solutions to Speed Problems

F/M SD 1 The level drops 1.2 inches.
F/M SD 2 The ♠6. West may continue a second spade instead of shifting to a diamond honor.

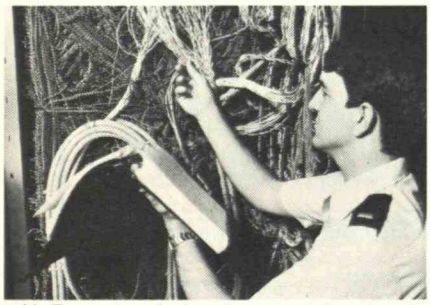
ENGINEERING TAKES ON EXCITING NEW DIMENSIONS IN THE AIR FORCE.



Computer-generated design for investigating structural strengths and weaknesses.

Developing and managing Air Force engineering projects could be the most important, exciting challenge of your life. The projects extend to virtually every engineering frontier.

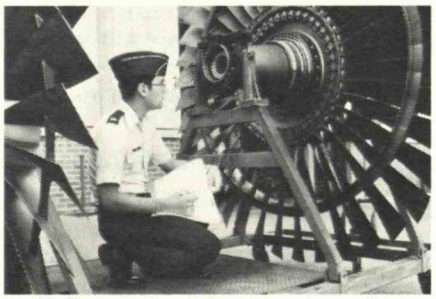
8 CAREER FIELDS FOR ENGINEERS



Air Force electrical engineer studying aircraft electrical power supply system.

Engineering opportunities in the Air Force include these eight career areas: aeronautical, aerospace, architectural, astronautical, civil, electrical, mechanical and nuclear. Hundreds of diverse specialties are included in a wide variety of work settings. For example, an electrical engineer may work in aircraft design, space systems, power production, communications or research. A mechanical engineer might be involved in aircraft structure design, space vehicle launch pad construction, or research.

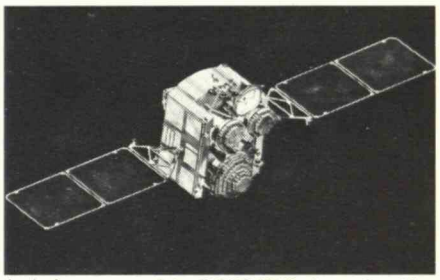
PROJECT RESPONSIBILITY COMES EARLY IN THE AIR FORCE



Air Force mechanical engineer inspecting aircraft jet engine turbine.

Most Air Force engineers have complete project responsibility early in their careers. For example, a first lieutenant directed work on a new airborne electronic system to pinpoint radiating targets. Another engineer tested the jet engines for advanced tanker and cargo aircraft.

OPPORTUNITIES IN THE NEW USAF SPACE COMMAND



Artist's concept of the DSCS III Defense Satellite Communications System satellite. (USAF photo.)

Recently, the Air Force formed a new Space Command. Its role is to pull together space operations and research and development efforts, focusing on the unique technological needs of space systems. This can be your opportunity to join the team that develops superior space systems as the Air Force moves into the twenty-first century.

To learn more about how you can be part of the team, see your Air Force recruiter or call our Engineer Hotline toll free 1-800-531-5826 (in Texas call 1-800-292-5366). There's no obligation.

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in the field of: _____

DEGREES NOW HELD (OR EXPECTED)

Bachelor's: Date _____ Field _____ School _____

Master's: Date _____ Field _____ School _____

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Regional electric rates vary by almost 10 to 1, yet high-rate areas do not appear to have more efficient air-conditioners. California, with efficiency standards, does.

Oak Ridge National Laboratory was unable to prove that they induced any additional conservation. So while approaches based on incentives may work, there is currently too little experience with them to make definitive predictions as to their effectiveness.

Rebates are also an expensive way to counteract market failures. Their economic justification is that the entity providing the rebate shares some of the benefits. A utility can afford to give rebates for efficient appliances because it can invest less in new power plants if its consumers conserve electricity. These new plants are costlier than existing plants so utilities can afford to pay a rebate equal to the expense they avoid.

Similarly, the government can afford to issue tax credits to pay for the public benefits of private conservation. It reduces the need to burn polluting fuels, strip-mine undeveloped land, import oil, and deplete domestic energy supplies. The value of such benefits can be paid as a bounty to those who conserve.

But rebates and tax credits that merely induce consumers to better their own well-being are less equitable than standards. The rebate provider is paying for benefits reaped by the recipient. Providing the incentive may still be cost-effective but it is not economically efficient.

Also, incentives are likely to help middle-class and wealthy consumers more than the poor. If energy-guzzling appliances are sold at all, they will most likely go to poor people. They tend to live in rental housing and buy used appliances, and therefore have the least choice as to appliance efficiency.

Expanded labeling and public education regarding energy efficiency is a policy economists frequently support because they say it does not restrict "consumer choice." But there is no evidence that labels have any effect: the PG&E study and the informal store surveys suggest that they are ignored. They do not circumvent the problems of supplying efficient appliances for rented dwellings or new homes, as well as of consumers who have difficulty paying for energy efficiency or who do not believe the labels. Current labels do not even prompt consumers to use an appliance's lifetime operating cost as a criterion for buying it. The Federal Trade Commission says that it could not require labels listing this information without a change in federal law. Also, the labels are just as indirect as the rebates: they leave both utilities and manufacturers facing an uncertain future.

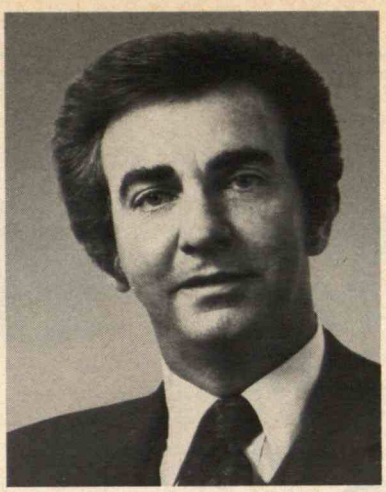
In response to the argument about restricting choice, it should be noted that efficiency standards do not restrict consumers' ability to select an appliance with any feature they desire, including automatic defrosting as well as a range of colors and sizes. There is at least as wide a variety of refrigerators offered in 1982 in California with regulations as there was in 1972 without them. Standards simply prevent consumers from spending too much to operate an appliance. This is sensible public policy, as individual consumers who decide to purchase inefficient appliances oblige utilities to construct expensive power plants and buy fuel.

Efficiency standards are even likely to help appliance manufacturers. If consumers ever do begin to respond to high electric rates, manufacturers will have to produce models of much higher efficiency to remain competitive—both in the United States and world markets. But that is not all. Manufacturers today face a great risk in designing the 1988 product line: how much emphasis should they place on efficiency? A wrong decision—to produce efficiencies that are either too high or too low—will be costly. Efficiency standards, by contrast, give manufacturers a known target, based on engineering requirements rather than uncertain sociological phenomena.

Promulgating efficiency standards is the only reliable way to achieve the full economic and environmental benefits of efficient appliances.

And the stakes are large. We at the Natural Resources Defense Council have estimated the costs of supplying energy for traditionally inefficient appliances, using a method similar to the one described for refrigerators earlier in this article. (However, in this calculation we do not require that all appliances be supplied by expensive base-power generating plants; air-conditioners, which need power only during relatively brief periods, are supplied by cheaper peak-load generation.) Constructing the power plants to supply electricity for traditionally inefficient appliances will cost $200 billion over the next 25 years, and the oil will be $5 billion a year. These expenses could be avoided if the country spends $40 billion on increased appliance efficiency. Failure to pursue the right policy could cost the United States dearly—even if there are no more oil embargoes.

DAVID B. GOLDSTEIN, who holds a Ph.D. in physics from the University of California at Berkeley, is a staff scientist at the Natural Resources Defense Council. He led a Lawrence Berkeley Laboratory study of residential energy use.



E. T. Bahre,
Chairman-CEO,
Computer &
Communications
Technology Corp.

"Puerto Rico has a positive can-do attitude. The government makes things happen."

"Puerto Rico's Economic Development Administration has initiated hundreds of successful start-ups," says Mr. Bahre. "They know the routine. So they're one step ahead all the way. That was an asset to us."

CCT's Information Magnetics subsidiary manufactures magnetic recording heads for computer disc drives. Its president, Fernando Velazquez, is one of the thousands of Puerto Rican born managers who hold top-level jobs with mainland subsidiaries here. CCT opened its doors in Puerto Rico in late 1980, and began shipping products within 60 days.

Mr. Velazquez adds: "Tax incentives are certainly a major benefit in Puerto Rico. But the key to it all is the people.

"We insist on testing every head we manufacture. Our Puerto Rican work force has a commitment to our high quality standards. They've already made beneficial improvements to our quality program."

Both executives agree that CCT is in a strong growth mode and will expand in Puerto Rico. Because this manufacturing center has the means "to produce and ship profitably."

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Fernando Velazquez,
President of CCT's
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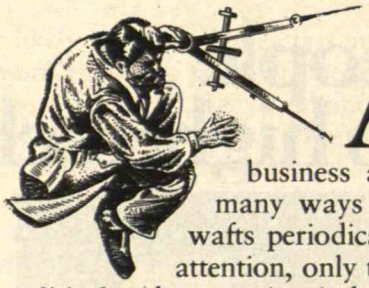
Measuring the Intangible in Productivity

BY MICHAEL B. PACKER

An organization's productivity cannot always be measured simply in terms of widgets per labor-hour. Analysts must account for subjective factors ranging from managerial effectiveness to customer satisfaction.



ANALYZING productivity within business and government organizations is in many ways like a hot-air balloon. The subject wafts periodically into public sight and managerial attention, only to drift slowly away with shifts in the political and economic winds. Few who work in the field appear to have a firm sense of where productivity analysis is headed, but there always seems to be enough talk about the subject to keep the balloon aloft.

What is organizational productivity analysis, and why has so little progress been made in the field over the past decade? To answer these questions, one must first examine what is meant by "productivity."

Attempts to define and measure the productivity of organizations have kept scores of consulting firms, academics, and managers gainfully employed for decades. Some definitions are of little help: "productivity equals motivation plus opportunity," for one, might prove rather hard to implement.

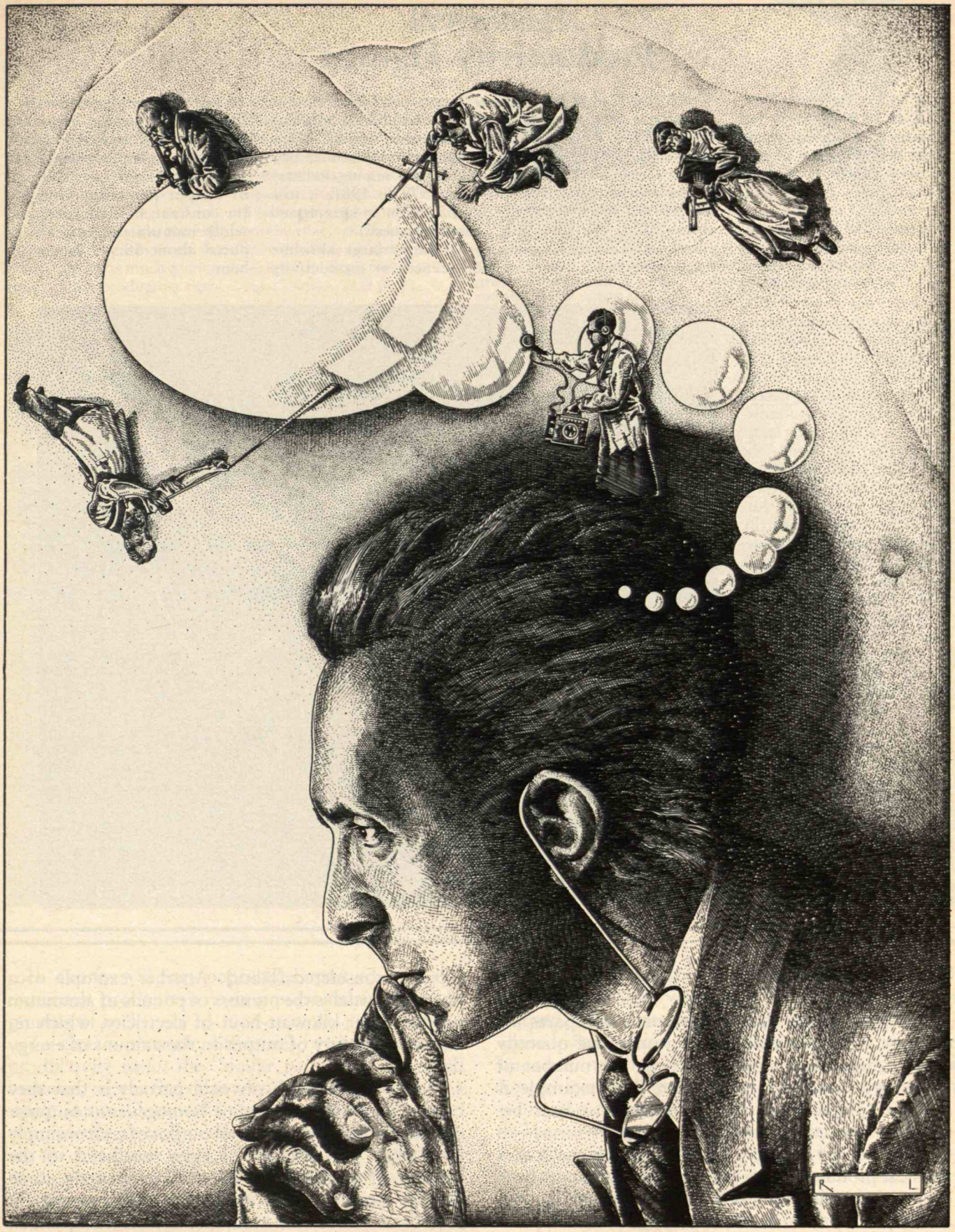


ILLUSTRATION: ROGER LEYONMARK

Historical Productivity Figures

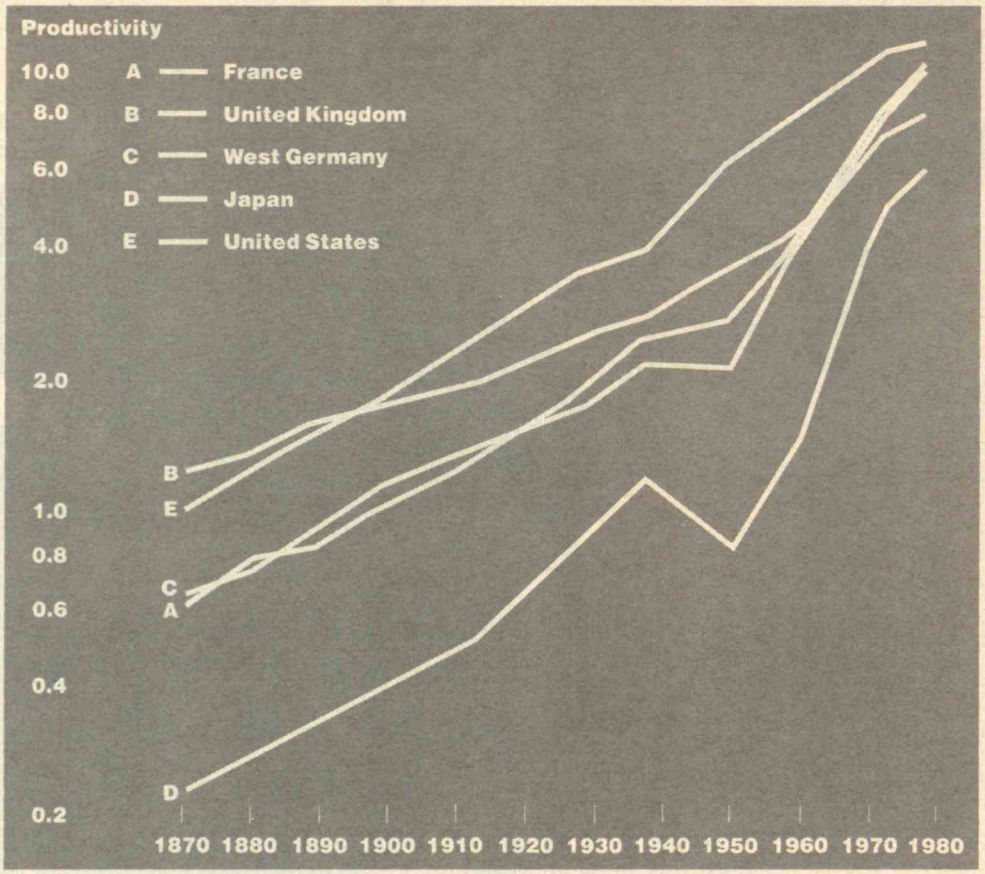
MUCH of the recent interest in productivity has stemmed from concerns about declining rates of productivity growth, both in the United States and abroad. The historical record is both interesting and controversial.

An international comparison of productivity levels, in terms of gross domestic product per labor-hour, shows that the United States has enjoyed a sizable lead throughout this century. The productivity of labor in this country is still higher overall than in others, but it is growing at a much slower rate. The productivity "gap"—the margin by which the United States leads other countries—has thus been closing. This trend, especially marked in particular industries, has attracted much media attention.

The productivity record of the United States betrays a further reason for concern. The growth rates of labor productivity and total-factor productivity (the value added during production, compared with the amount of labor and capital used) have both been dropping steadily since World War II. And for three consecutive years from 1978 through 1980, labor productivity actually declined in absolute terms in the United States. Despite extensive analysis and much academic squabbling, the ultimate causes of this decline have not been established.

In any case, the decline in productivity has not affected all industries equally. While productivity declined 2.5 percent in the mining industry from 1979 to 1981, it rose over 5 percent in farming and communications.

Strikingly large absolute differences in productivity among different industries further illustrate the heterogeneity of the economy. In 1981 the communications sector produced over $20 of output per labor-hour (in constant 1972 dollars), while manufacturing produced about $8 per labor-hour.



Relative productivity in several countries, comparing their gross domestic product per labor-hour with that of the U.S. since 1870. (Source: Angus Maddison and American Productivity Center)

When Counting Works

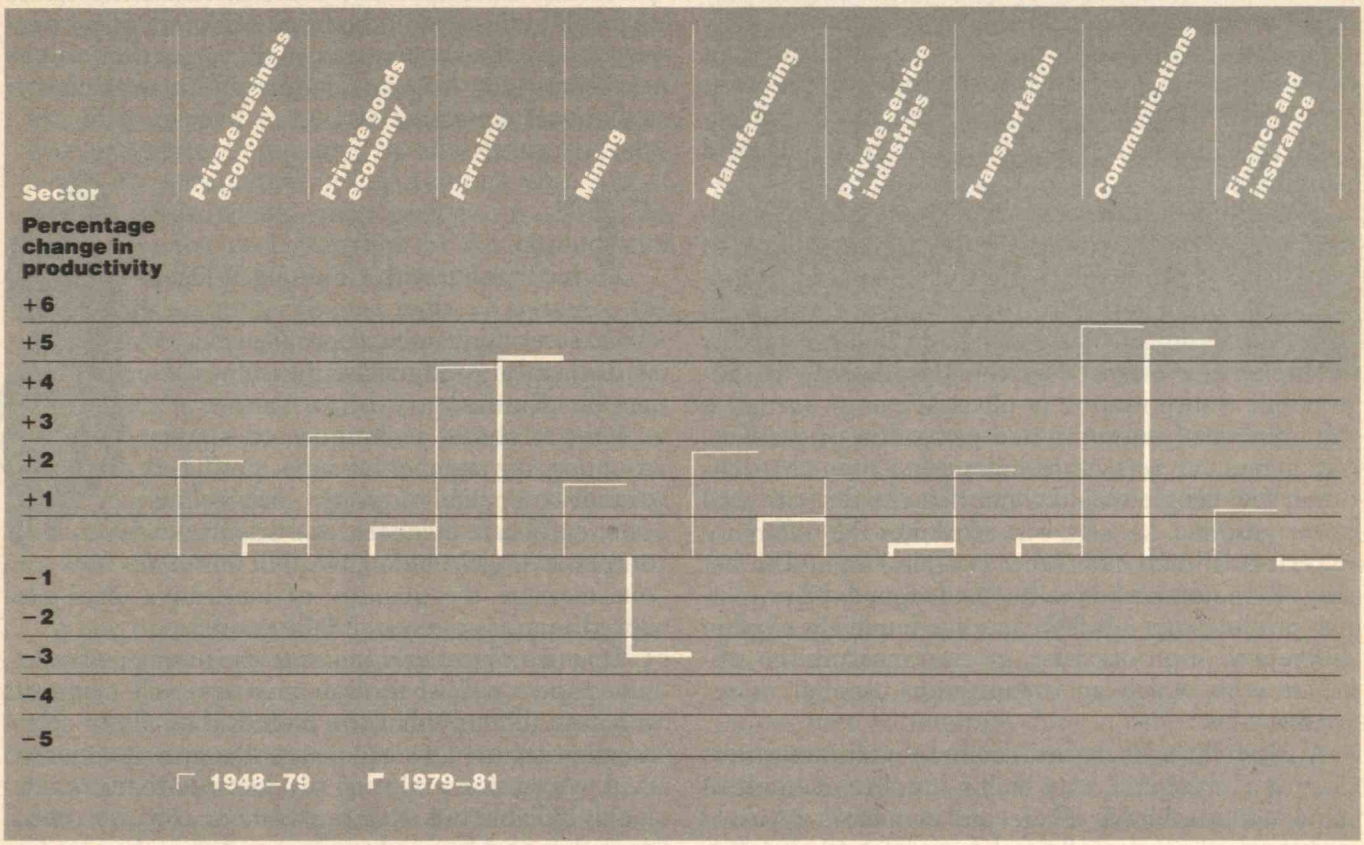
A more useful and classical approach compares the quantity of output with the corresponding quantity of one more more inputs, such as the number of forms processed per labor-hour. This example is called a "physical partial productivity" measure because it relates the gross physical output—forms—to the quantity of a single input—labor-hours. It is a physical productivity measure because it counts both output and input in physical units (forms and hours). It is a partial measure because only a single type of input is considered (labor). Another example of a physical partial is the number of pounds of aluminum produced per kilowatt-hour of electricity, which relates the quantity of output to the amount of energy used.

One difficulty with physical partials is that they can be used only to examine homogeneous outputs: one cannot compute the total output of a farm simply by adding the number of eggs produced to the amount of butter made. Even outputs of the same general type may pose difficulties. For example, if rock density is not constant, the measured output of a

DIAGRAMS: OMNIGRAPHICS

Relatively little research has been done on the variations in productivity among firms within the same industry. However, the differences that have been uncovered are dramatic. According to Census Bureau statistics, the top quarter of the firms in an industry can be as much as nine times more productive than those in the bottom quarter. These huge differences remain even if one compares facilities that are matched in terms of age, products manufactured, and other factors. The implications of these productivity differences are strong: there is substantial room for improvement in most firms.—*M.B.P.* □

Productivity in selected sectors of the U.S. economy. Overall productivity in the private business economy actually declined during 1978, 1979, and 1980, in terms of gross domestic product (in 1972 dollars) per labor-hour. But the results vary from industry to industry. For example, productivity grew 5.5 percent in communications while falling 2.5 percent in mining from 1979 to 1981. (Source: American Productivity Center)



rock quarry will vary depending upon whether one evaluates production in terms of cubic yards or pounds of rock.

To deal with such difficulties, a second type of productivity ratio, the "dollar partial productivity" measure, relates the value of output to the value of a single input. One could thus use dollar partials to compute the overall productivity of a farm by dividing the total sales value of eggs and butter produced by the total cost of, say, labor. (The values can be expressed in dollars actually spent or in "real" dollars adjusted for changing prices.) Instead of measuring the gross value of output, some analysts calculate dollar partials using "value added"—the value of gross output minus that of all materials and supplies purchased. Both forms of dollar partials are attractive because nonhomogeneous outputs—eggs and butter—can be aggregated by expressing all output in terms of a common unit—dollar value.

These two types of productivity measures are frequently crossed in "mixed partial productivity" figures. Here output is expressed as a dollar value, while a single input is measured in physical terms, or vice-versa. For example, the value of production could be

The shift from agriculture and manufacturing toward service industries raises fundamental questions about our definition of productivity.

compared with the number of labor-hours required, or the number of forms processed could be compared with the total labor cost. The national productivity figures reported by the press are mixed partials, usually consisting of a value-added measure of output for an industry (or the whole economy) divided by the number of labor-hours involved.

The principal drawback of all three types of partial productivity measures is that they account for only one kind of input at a time. A partial productivity figure may measure only labor input, yet the amount of output is influenced by a host of other factors such as the level of automation in the operation, government regulation, the quality of raw materials, and plant layout.

This problem is the root of a common error in interpreting productivity figures. Poor growth rates of partial labor productivity are often imputed to lazy workers, although they can more often be attributed to other factors such as low capital investment. For example, one measure of the productivity of automobile transportation (a physical energy partial) is the number of miles traveled per gallon of gasoline. Yet if one car gets more miles per gallon than another, few people would claim that the first car used better gasoline. Instead, one attributes the difference in performance to differences in capital input: the fact that one automobile was better designed. Thus, partial productivity figures cannot completely explain differences in productivity, or even measure the efficiency with which an organization uses all its resources.

Analysts have therefore devised "multifactor productivity" measures, in which a number of kinds of input are combined. There are two basic types of multifactor measures. "Total factor productivity" is defined as the real value added during production divided by the real value of labor plus capital. "Total productivity" relates the real value of gross output to the real value of all inputs combined: labor, capital, materials, services, and energy.

The simplicity of these classical productivity formulas belies the difficulty of applying them in organizations. Information on the price and quantity of all inputs and outputs is often not available. In a conglomerate with 200 subunits, each producing hundreds of products and using supplies from thousands of vendors, there may be no way to get all the necessary figures. New products raise particularly frustrating problems. If over a two-year period a toy company changes almost its whole product line from mechanical to electronic models, did the change in the firm's productivity stem solely from the change in products? Measuring capital input is also difficult: how should the value of machinery be allocated among the many products made over the years?

By the early 1960s, analysts had made substantial progress in devising methods for dealing with these problems. Unfortunately, more fundamental issues that call into question the basic definition of productivity have become increasingly important as the economy shifts from agriculture and manufacturing toward service activities.

The Trouble with Counting Widgets

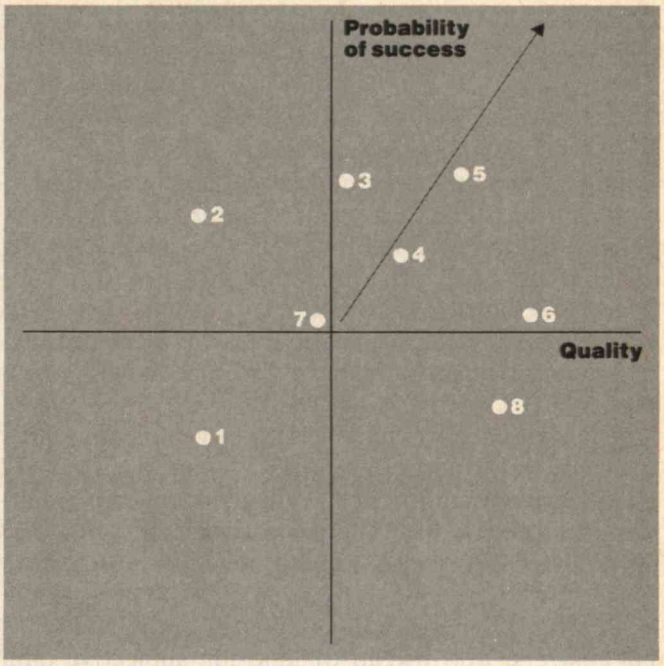
At least six fundamental problems with classical productivity measures can be identified.

First, classical techniques of simply counting the number of units produced cannot be applied to groups such as lawyers, corporate planners, and scientists whose output is largely intangible. For example, how can one measure the quantity of innovative ideas produced in a basic research laboratory?

One can objectively measure the number of scientific papers published. But most research managers care less about publication records than about an intangible factor: how innovative the group's research is. A system for analyzing productivity that provides highly reliable but irrelevant data is not very useful. And this problem is becoming more widespread as more workers in industrialized countries are engaged in intangible service activities such as research and development.

Second, classical techniques are frequently inapplicable to custom or small-batch manufacturing operations, since the resulting products, although tangible, cannot be easily compared. Does a Voyager spacecraft represent twice as much output as a communications satellite? How does one compare an oil tanker with a banana ship?

Third, even in the case of tangible products produced by repetitive processes, classical techniques may be inadequate because they fail to take into account customers' subjective perceptions. In the case



A perceptual map evaluating research projects in terms of their quality and probability of success. The center of the map represents the norm; better performance is indicated by a position above and to the right of the center. The arrow is the "ideal vector" representing managers' assessment of the optimal trade-off between probability of success and quality.

of services such as social work, medical treatment, and consulting, the recipient's assessment of the service cannot be divorced from a meaningful definition of output. The effectiveness of psychiatric treatment depends as much on the patient's perception of the treatment as on its amount and nature. What is less often recognized is that the same concept applies to mass-manufactured goods such as automobiles and industrial fasteners. A customer who buys such a product is buying a reputation for quality, an expectation about ease of repair, and a host of other intangibles in addition to the physical product. Since a firm must expend resources (inputs) to foster these favorable perceptions—first by advertising and ultimately by substantiating expectations with actual product performance—such perceptions should be included in the very definition of the product and thus counted as part of an organization's output.

Fourth, classical techniques focus on outputs—the immediate results of organizational activity—rather than outcomes—the ultimate impact of the organization upon the outside world. For example, the outputs of congressional staffs include legislative analyses, and those of market-research groups include market studies. However, the corresponding outcomes should include better-informed legislation for the nation and improved marketing strategies for the firm.

While outputs are usually easier to quantify than outcomes, we often care more about outcomes than outputs. This is particularly true in the case of knowledge work, such as that conducted at educational institutions and government agencies. For example, the immediate output of the local police includes items such as arrests and traffic tickets. Yet the public is less concerned with the number of arrests than the overall crime rate, which is affected, but not directly controlled, by police activities.

The distinction between output and outcome is mirrored in the twin concepts of efficiency and effectiveness. Efficiency refers to how well the enterprise converts its input resources into immediate outputs—how productive the organization is in doing whatever it does. Effectiveness, on the other hand, relates to how well the enterprise uses its input resources to meet its ultimate goals and purpose—how productive the organization is in accomplishing what it should be doing. A military purchasing office that processes many procurement requests per labor-hour is efficient. If it expeditiously acquires equipment of maximum performance at minimum cost, it is effective as well. Traditional formulas for measuring productivity stress efficiency and neglect effectiveness.

Fifth, classical techniques do not provide enough tools for interpreting productivity data. If a manager slows down an assembly line, the number of defective products often decreases. Will the increase in quality be worth the reduced production rate? Productivity analysts have generally not employed common techniques used to interpret data in other fields such as economics and market research. For example, some department stores adjust sales figures for seasonal factors. Managers know sales will invariably be high during the Christmas rush, so they check whether sales are merely normally high or whether they are high enough to indicate long-term growth. However, most businesses do not use even simple techniques such as this.

Finally, classical techniques provide little guidance to managers who are trying to choose among a variety of ways to improve productivity. Since classical techniques fail to provide information about employee motivation and management style, executives cannot integrate sociological factors with the technological factors important in improving productivity.

Why has so little progress been made in these problem areas over the past decade? And why have these fundamental questions been largely ignored despite

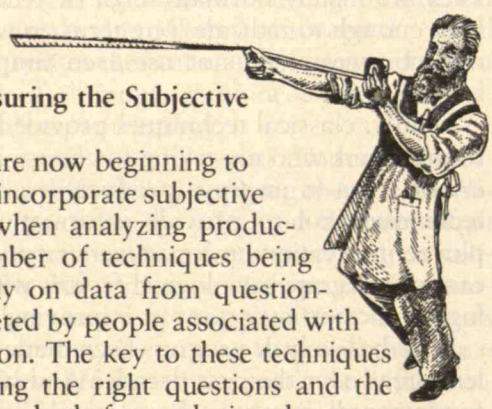
the recent flood of media publicity about productivity? The most plausible reason is that analysts hesitate to grapple with the common element in all these areas: the need to gather and analyze inherently subjective information about output.

One cannot count the number of items produced if, as in basic research, output is largely incorporeal. When examining tangible but unique products such as different spacecraft, the analyst must resort to subjective assessments to compare the outputs. Trying to weigh the effect of employee motivation in productivity improvement programs is also a subjective process.

Analysts have skirted the issue of subjective productivity information because of concern that responses to questionnaires and other subjective data would be unreliable. There are two issues: whether subjective information actually reflects the situation in the organization, and whether different people evaluating an organization's outputs would give similar answers. But instead of ignoring subjective data entirely, productivity analysts could examine their reliability by established statistical techniques from fields such as educational testing.

Managers already make decisions based on their own judgment and perceptions; subjective productivity analysis simply makes this process more explicit and rigorous. Managers should also admit that a single definition of productivity will not suffice for all situations. In R&D one might be interested in originality and quality of ideas, while in manufacturing, production rates might be stressed. Moreover, different groups connected with the organization, such as senior management, employees, and customers, may disagree about what constitutes useful output.

Measuring the Subjective



Researchers are now beginning to learn how to incorporate subjective assessments when analyzing productivity. A number of techniques being developed rely on data from questionnaires completed by people associated with an organization. The key to these techniques lies in selecting the right questions and the appropriate methods for analyzing the responses.

To choose a pertinent set of questions, one must determine who is going to use the productivity data and for what purpose. Thus, line managers might want reliable, detailed information to improve day-to-day production, while a strategic planner might be concerned with broad business trends over a period of years.

The questions must be tied closely to the goals of a particular organization. For example, research managers connected with a university might be concerned with whether work is original, while managers in the R&D division of a food-processing company might worry about whether research will yield a profitable product in a few years. Trying to identify an appropriate set of goals for an organization is perhaps the most difficult and time-consuming part of the entire process. Yet measuring activities that do not further the organization's overall strategy clearly makes no sense.

After the goals of the organization have somehow been established, the next step is to develop specific questions that measure the extent to which these goals are being achieved. The problem is that most managers care about fairly abstract aspects of output such as research quality and originality. Yet if they were asked to rate research projects in terms of overall quality, they might raise an eyebrow at the academic naivete of the question—it is simply too vague. Managers could respond more meaningfully to a list of detailed questions such as: "To what extent does this project show mathematical ingenuity in simplifying the governing equations of fluid flow?" Several methods can be used to create a list of such questions. A group of people connected with the organization might gather and—using procedures designed to eliminate criticism and encourage participation—generate 30 or 40 detailed questions in an hour.

In a recent analysis of computer-aided design (CAD) in one company's engineering department, managers wanted to know not only how much CAD systems enhance pure efficiency, but the degree to which they affect intangibles such as creativity and flexibility. Researchers and managers identified a number of these intangible goals and helped create a list of 38 related questions. For example, one question concerning the goal of better communication was: "How easy or difficult is it for you to get help from people outside your immediate work group who have information you need?" Members of both manual and com-

If a military purchasing office processes many procurement requests per labor-hour, it is efficient. If it expeditiously acquires high-quality equipment at a reasonable cost, it is effective.

puter-aided design groups then answered these questions.

The problem with a list of questions long enough to cover everything meant by effectiveness is how to interpret the resulting abundance of information. If one project is rated higher than another in 19 out of 38 detailed questions, which would be of higher quality?

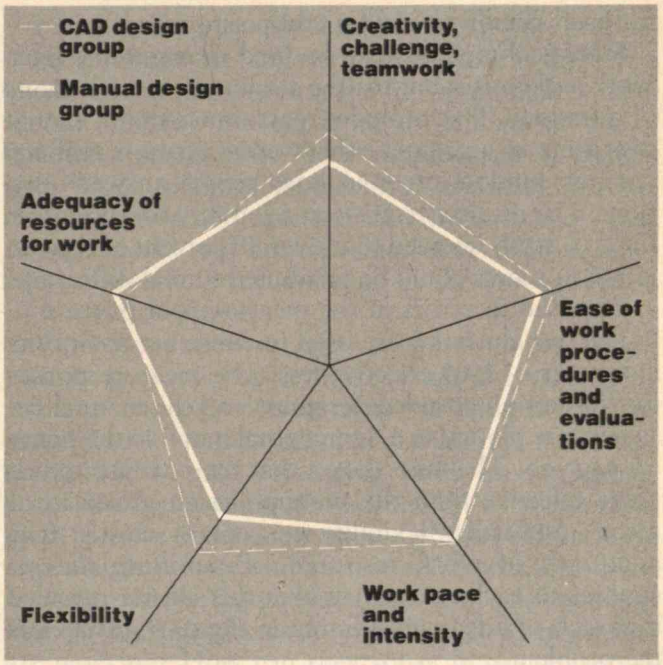
Several techniques can be used to organize this mass of information by grouping questions together and summarizing the responses to each group by a single composite measure. If responses to the questions are scored on a scale from one to seven, the value of each composite measure is usually found by adding the scores of all questions in the group.

The simplest clustering method is to group intuitively similar questions together. For example, "How difficult or easy is it to redimension a drawing?" seems related to "How difficult or easy is it for you to make changes to improve a design?" Both questions concern work flexibility. But neither has much to do with an inquiry about feedback such as, "How well or poorly do you know what is expected of you in terms of quality?"

Statistical techniques such as factor analysis and hierarchical cluster analysis can also be used to group questions. These techniques, which group questions together if the responses correlate closely, cluster the of questions with more precision and rigor than an intuitive approach. The advantage of both intuitive and statistical methods is that one can ask detailed, meaningful questions, group them together, and obtain a composite measure of abstract aspects of output such as quality. It is these broad aspects that managers care about but that are too vague to ask about directly.

In the case of the CAD systems, factor analysis was used to group the questions into five clusters. Each cluster can be labeled according to the nature of the questions grouped in it.

The first cluster contained questions relating to the level of creativity, challenge, and team effort involved in work. Freedom to choose appropriate work methods was important, and intriguingly, the statistical procedure also grouped an indicator of personal morale in this cluster. The second cluster dealt with the feedback designers received about their performance and the ease with which they were able to do their work. The third cluster included indicators of work pace and intensity, while flexibility was the



A perceptual map comparing the performance of designers who work manually with that of other designers who use computer-aided design (CAD) methods. Each axis corresponds to a particular aspect of work such as flexibility or pace and intensity; the distance from the center represents the group's score. The CAD group did better than the manual designers in all areas but one.

theme of the fourth cluster. Finally, the fifth cluster dealt with the adequacy of resources—tools, equipment, information, and training.

While these labels distill the abstract concept associated with each cluster, such groupings do not always make intuitive sense. At least one question in each cluster did not appear to belong with the others. In some cases it may be perfectly valid to move certain questions to other clusters or to omit them entirely.

Grouping questions into clusters also improves the reliability of subjective evaluations by allowing random effects to cancel out. This statistical phenomenon is similar to that which occurs in a spelling test. A test with only one question may be an unreliable measure of spelling ability because some students may be excellent spellers but may not have learned a specific word. A test with many questions is a more reliable measure of spelling ability because random learning effects average out. Thus, one can construct a more reliable subjective measure of output by asking a number of questions and adding the responses

Researchers might rate an innovative project highly, marketing managers poorly. Productivity analysis can elicit the true disagreements and make communication effective.

for each person to yield a composite measure.

Statistical methods can be used to assess the reliability and consistency of the responses in each group of questions. This provides reassurance that a change over time in a group's effectiveness score is real and not just random error in how people answer questions. The resulting statistical reliability coefficients in the CAD study showed that over 80 percent of the variation in scores could be attributed to real differences as opposed to errors in the measurement process.

The five clusters were used to construct composite indicators of CAD effectiveness. The mean responses for the computer-aided designers and the manual designers are plotted in a "perceptual map" in the figure on page 55. The map shows that the CAD group was more effective than the manual-design group in all areas—especially flexibility—except in cluster five, adequacy of work resources. Examining the responses to each question within this cluster revealed that lack of adequate training in the CAD group was the problem.

Another survey at a research consortium sponsoring eight research projects further illustrates the power of perceptual mapping. (This example has been modified for simplicity.) As in the previous case, detailed questions concerning the projects were generated and grouped into composite clusters representing four factors of effectiveness—quality, probability of success, profit potential, and probable completion time. The values for the quality of a project and its probability of success are shown in the perceptual map on page 53. (Other factors could be plotted on other maps.)

The perceptual map shows the extent to which an organization meets its various goals such as quality and profit potential. However, before one can evaluate the overall effectiveness of an organization, the relative importance of these goals must be assessed. To do this, the managers in the research consortium were asked to rank all the projects according to their intuitive sense of each one's effectiveness. While managers often cannot fully explain their feelings and may disagree, they frequently have a strong sense of how projects should be ranked. Other statistical techniques were used to relate the overall rankings of projects to the four composite factors, and the results showed the relative importance managers assigned to each. The best projects were found along an "ideal vector"—the heavy arrow in the perceptual map—representing an ideal ratio of probability of success to quality. (Similar ideal vectors could be drawn on maps relating other composite factors.)

The perceptual map provides an explicit picture of the abstract concepts managers use to evaluate projects, and therefore gives managers insights into their own preferences. As indicated by the ideal vector, managers at the research consortium believe that the quality of a project is somewhat less important than its probability of success. The closer a manager can bring a project to the ideal vector, the greater its overall effectiveness. Project 2 can increase its effectiveness by stepping up its quality, while project 6 could more nearly approach the ideal vector by concentrating less on the scientific quality of the research and more on a higher probability of success. If projects are altered or new ones initiated, it is easy for managers to evaluate them according to the list of detailed questions and to create a new perceptual map.

When marketing managers rather than research managers answer the same detailed questions, they tend to evaluate the quality and probability of success for each project similarly, but they differ about which characteristics are more important. For example, marketing managers usually emphasize profit potential and quick completion time more than pure research quality. By drawing a separate perceptual map for each group of persons associated with the organization, one can make disagreements explicit. The disagreements may persist, but the groups are at least able to communicate clearly about them.

The perceptual mapping technique thus measures the intangibles that managers instinctively think about—abstract concepts such as quality—and not just factors that happen to be objective and easily countable. As a result, this technique can measure productivity and effectiveness even in organizations that produce entirely intangible output.

Problems with Subjective Measures

A variety of such techniques now exists for analyzing subjective judgments about organizational output and productivity. Productivity analysts are on the verge of exciting developments that will make it possible to evaluate productivity across the full spectrum of organizations in the economy, from

Does a Voyager spacecraft represent twice as much output as a communications satellite?

manufacturers to service organizations. Yet a nagging suspicion remains that managers will somehow still find reasons to be unhappy with these techniques.

Managers usually raise three major objections. The first concerns the difficulty of obtaining responses to questionnaires. In certain cases, such as hospital emergency rooms, it may be inconvenient for the organization's customers or clients to fill out questionnaires. This eliminates one important constituency from the evaluation process. Even in more prosaic situations, people often resent taking the time and trouble to respond. Although this resistance can be mitigated by a well-designed questionnaire and by involving the organization's members in the design process, monitoring of performance is difficult.

A second problem relates to the need for some statistical analysis. Many managers understand statistical methods on a conceptual level but quickly become traumatized at the prospect of using a computer to actually do the calculations. Moreover, someone in the organization must understand the techniques well enough to detect possible errors or biases in the results. The need for statistical analysis can be kept to a minimum, but at some point managers must be willing to deal with basic statistical methods if they wish to have better information about productivity.

If these were the only objections, new techniques for analyzing productivity would surely find a niche in the arsenal of management methods. But a third problem bedevils the field: managers search for simplicity and stability in an environment that seems to be increasingly complex, unstable, and unpredictable.

While most managers understand that productivity cannot be measured by a single number, they still yearn for an easily defined, concrete procedure that will yield a small set of objective measures. They want a definite answer when they ask whether their organizations are "doing well." Yet productivity analysis is an untidy, often frustrating procedure for which the only rule is that simple answers do not exist to the question, "What is our productivity?" The recent history of the Environmental Protection Agency shows, for example, that different groups such as developers and environmentalists disagree vehemently about what makes an organization effective, much as researchers and marketing managers might disagree on the productivity of an innovative though possibly unprofitable R&D project.

But this disagreement does not mean that productivity analyses are useless. In most cases, there is a consensus on the specifics: the EPA is doing less regulating; an R&D project is highly innovative but of uncertain profitability. The disagreement is usually over which qualities should be emphasized. Productivity analyses can uncover the true nature of these disagreements and attach remarkably reliable numbers to specific attributes such as the innovativeness of a research project.

While productivity improvement is indeed an important goal, managers make a mistake when they rush to improve productivity without laying the groundwork for measuring and analyzing it. Innumerable highly paid consulting firms tout programs such as robotics and quality circles (in which workers meet to solve production-related problems) that seem appealingly simple and concrete. Yet without some tools for measuring productivity, how can managers know which programs to choose and whether they are working? How can they solve an organization's productivity problems without being able to evaluate which are most serious? And how can they serve customers without assessing their opinions about the organization's effectiveness?

Productivity analysis is no less essential because it is untidy, because the results depend upon one's point of view, and because no single procedure will lead to objective, easily obtained numbers. The trick for managers is to learn how to mix a variety of tools and techniques to keep their organziations edging toward improvement.

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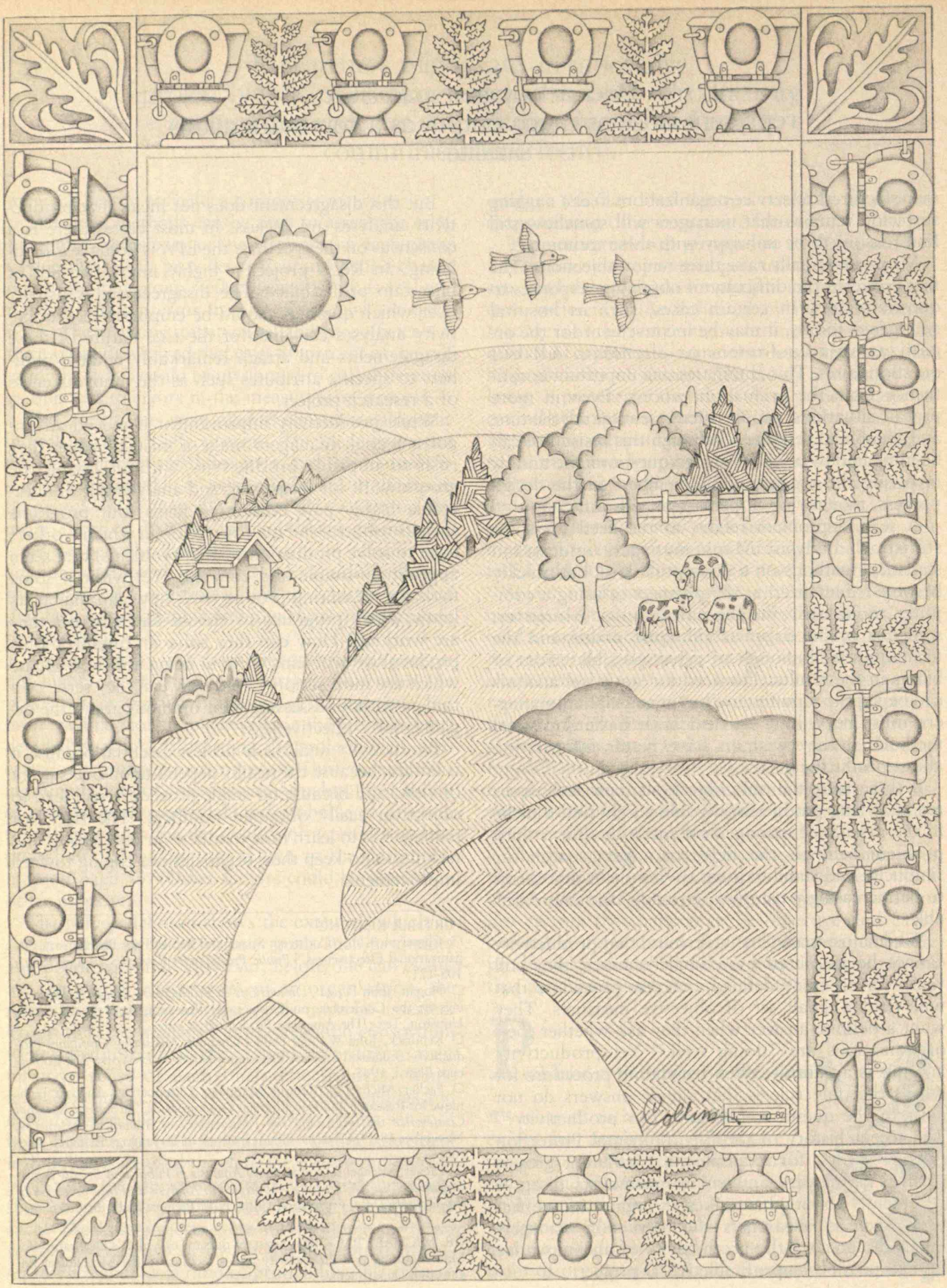

Collins

Waste Treatment: Doing What Comes Naturally

By taking advantage of nature's recycling systems, cities can reduce the steadily increasing cost of treating sewage while putting this "resource" to productive use.

BY ROBERT K. BASTIAN AND JAY BENFORADO

Some 15,000 municipal sewage-treatment plants in the United States handle more than 26 billion gallons of wastewater each day, serving about 150 million people and at least 87,000 industries. Much of the treated wastewater—called effluent—flows after treatment into streams, lakes, and coastal waters—often to their detriment. The treatment plants also generate more than 17,000 tons (dry weight) of sludge, the solid material removed from the wastewater, every day. Sludge has traditionally been disposed of by incineration, burial in landfills, land application, and ocean dumping. But each option poses environmental concerns and economic barriers that in turn pose serious problems for many communities.

ILLUSTRATIONS: DAN COLLINS

What's more, both wastewater and sludge are steadily increasing in quantity. This is because population is growing, municipal treatment plants are serving more industries, and federal and state regulations require more thorough treatment of sewage. Treatment plants in 1985 will handle about 15 percent more wastewater and sludge than they did in 1980, and treatment and disposal will also cost more as the prices of labor and energy continue to rise. At the same time, water pollution remains a serious national concern, and supplies of fresh water for irrigation, recharge of groundwater, and industrial and municipal uses are becoming scarce in some regions of the country.

Ironically, we can alleviate such problems by looking at municipal wastewater and sludge as valuable resources. By adopting "natural" treatment systems, many communities can handle their sewage more economically while recycling and reusing the materials productively. These materials are rich in important nutrients: a year's worth of treated wastewater and sludge contains an estimated 1.4 million tons of nitrogen, 300,000 tons of phosphorus, and 600,000 tons of potassium. This represents roughly 10 percent of the amounts of these nutrients now supplied by commercial fertilizers—worth about $950 million at current prices.

Wastewater and sludge also contain many micronutrients that are essential for plant growth, organic matter that is valuable as a soil conditioner, and enough water for one-sixth of the nation's irrigated land. In many cases, the "products" of natural waste-treatment systems can be used to improve farmlands, reclaim strip mines and other disturbed lands, create new recreational areas, recharge groundwater supplies, and produce marketable crops—all of which can help offset treatment costs.

The challenge is to learn how to manage natural ecosystems so that they can safely and effectively assimilate and recycle sewage wastes. With better understanding of how ecosystems function, we can also develop "artificial" natural systems that capitalize on the capabilities of these same processes. Some natural treatment systems are already widely accepted, and many others are being investigated in the United States and abroad. They make use of a diversity of ecosystems, including farmlands, forests, ponds, and wetlands, and they range from variations on traditional land-treatment concepts to intensive aquaculture systems.

Back to the Land

Applying wastewater and sludge to the land has evolved from the time-honored practice of recycling animal manures and agricultural residues. There are three major types of land-treatment systems for municipal wastewater.

☐*Slow-rate land treatment.* Similar to conventional crop irrigation, this relatively popular alternative recycles nutrients and produces a potentially marketable crop while reclaiming wastewater. Partially treated wastewater is applied to vegetated lands, and the soil, plants, and microorganisms clean the water as it soaks in and gradually percolates to the groundwater. Systems used to irrigate farmlands, old fields, and forests are currently operating successfully in many parts of the country.

For example, Clayton County, Ga., located just south of Atlanta, recently started up a slow-rate system that will treat 20 million gallons of wastewater per day by applying it to a 2,400-acre forest of loblolly pines. Costing $43 million to construct, it is one of the largest systems operating year-round. The forest is divided into seven sections, and the water is sprayed through a network of sprinklers. Once a week, each section receives 2.5 inches of wastewater over a period of 12 hours. The trees, to be sold as pulpwood to help offset operating costs, will be harvested on a 20-year rotation cycle. Since the forest is located in the community's watershed, the wastewater eventually becomes part of the drinking-water supply. Other relatively large slow-rate systems—each treating more than 20 million gallons per day—have been installed in Michigan and Texas, while smaller systems operate in at least 40 states.

☐ *Rapid infiltration.* This system is usually used independent of agriculture and forestry operations. Wastewater is cyclically applied to basins containing coarse, highly permeable soil. Physical, chemical, and biological cleaning occurs as the wastewater drains through the soil to the groundwater. (All land-treatment systems use alternating wet and dry periods; this schedule optimizes microbial activity, prevents waterlogging and keeps the soil from becoming clogged with suspended solids.)

Rapid-infiltration systems are gaining in popularity but are still less widespread than slow-rate systems. They are somewhat more limited than slow-rate systems by the need for highly permeable soils and certain underground drainage patterns. Phoenix now

uses a large system of this type, while smaller systems are operating in at least 24 states, including New York, Massachusetts, and New Jersey.

☐ *Overland-flow land treatment.* Wastewater is applied at the top of grassy slopes, which are underlain by a relatively impervious soil layer. The water flows in a thin film down the slope and is cleaned by the soil, vegetation, and microorganisms at the soil surface. The water is collected in open ditches at the bottom for reuse or discharge to surface waters. The slopes must be steep enough to prevent "ponding" of the runoff, yet gentle enough to prevent erosion and allow the water enough time to be purified. The slopes must also be carefully graded and kept free from gullies to prevent channeling and allow uniform distribution of the water over the surface. Naturally rolling terrain is easily adapted to the network of slopes and terraces needed for an overland-flow system, minimizing land-preparation costs. Cities can install such systems to preserve green belts and open spaces. In other locations, the systems may be used to produce forage grass for feeding cattle. Perennial grasses with long growing seasons, high moisture tolerance, and extensive roots are best for this purpose.

The city of Davis, Calif., has installed one of the largest municipal overland-flow systems, which treats about 5 million gallons per day. Smaller or experimental systems are operating or are under construction in at least 15 states, including New Hampshire, South Carolina, Mississippi, Texas, and Illinois. The first systems were built in relatively warm climates, but recent advances in construction and design and greater operating experience have made them useful in cooler regions as well. Although overland flow has only recently been used to treat municipal wastewater, such systems have proved their worth in treating food-processing wastes for over 25 years.

Land-treatment systems can clean wastewater to a purity that equals or exceeds some of the most sophisticated conventional treatment processes. The systems also cost less to build and operate than more highly engineered systems—if enough land is conveniently available at reasonable cost. For small treatment plants handling less than 1 million gallons per day, a 25 percent savings in construction costs and 50 percent savings in operation and maintainance costs (partly because they use much less energy) have been fairly common. In larger metropolitan areas with very large volumes of wastewater, these systems may be less practical because of land availability problems. However, large slow-rate systems may be attractive in regions where water is needed to irrigate crops. A slow-rate system usually requires 50 to 500 acres per million gallons of wastewater handled daily. Rapid-infiltration and overland-flow systems require 2 to 50 acres and 15 to 100 acres per million gallons a day, respectively. Both the land requirements and performance of similar projects can vary considerably due to local factors such as soil properties, wastewater characteristics, application rates, crops grown, climate, and the desired level of treatment.

Turning Sludge Into Gold

Processing and disposing of sludge frequently accounts for 50 percent or more of the costs of operating a typical sewage-treatment plant. And with the usual disposal methods limited by lack of acceptable sites, rising costs, environmental problems, and legal restrictions, some communities have turned from a philosophy of disposal to one of reuse. Indeed, about 20 percent of the nation's sewage-treatment facilities currently rely to some degree upon land application as a sludge-management practice. Sludge reuse projects are underway in many large metropolitan areas, including Milwaukee, Chicago, Denver, San Diego, Seattle, Philadelphia, and Washington, D.C., as well as in thousands of smaller cities and towns across the country, especially in the Midwest. The sludge is being recycled as a soil conditioner and organic fertilizer on cropland, pastures, sod farms, golf courses, parks, forests, and disturbed areas.

Raw sludge is 96 to 98 percent water; only 2 to 4 percent consists of solid material. It contains many microorganisms that can cause disease and material that can produce objectionable odors. Therefore, the sludge usually must be processed to "stabilize" it before it is applied to land. Sludge can be stabilized in a variety of ways, including composting, heat treatment, and digestion. "Anaerobic" digestion, in which sludge is decomposed by bacteria in the absence of oxygen, is the most widely used.

Stabilized liquid sludge can be sprayed directly onto the soil surface, incorporated into the upper soil layer by plowing, or injected beneath the soil surface with specially designed injection systems. However, sludge is frequently "dewatered" in drying beds exposed to the sun or with the aid of vacuum filters, centrifuges, filter presses, belt presses, and even thermal dryers. This concentrates the sludge solids and

Federal Policies: From Add-On to Innovative

MANY municipal sewage collection and treatment systems were built in the late 1880s and early 1900s, primarily to protect public health. These plants usually provided "primary" treatment to remove large objects, floating materials, and settleable solids in the raw sewage.

Later, as the public grew increasingly concerned about environmental problems, cities in heavily polluted areas gradually turned to "secondary" treatment as well. These plants use physical, chemical, and biological processes to break down organic matter and remove many of the suspended particles left after primary treatment.

Most communities are now required by federal and state regulations to provide secondary treatment. And in recent years, some communities have been required to do even more. "Advanced" or "tertiary" treatment goes after compounds dissolved in wastewater. These range from various nitrogen, phosphorus, and other inorganic chemicals—which, if discharged in large quantities, can cause rampant growth of algae or other water-quality problems—to an ever-increasing number of synthetic organic compounds including PCBs and pesticides.

During most of the last 10 years, the U.S. Environmental Protection Agency (EPA) has pursued a "technology-based" approach to controlling water pollution. Municipalities and industries have been required to meet specific levels of wastewater treatment and to use certain kinds of treatment processes. However, the emphasis on "add-on" technologies to achieve incremental improvements has locked many communities into costly, relatively inflexible, technologically complicated systems.

Many of these systems use large amounts of energy—the treatment plant in a small town may require more energy than any other public service—while energy costs have more than tripled since 1970. Cities have had problems disposing of the large quantities of sludge that result when wastewater is treated to ever higher levels of quality. And conventional treatment plants often don't perform as well as they should because of low budgets, negligence, and poorly trained operators.

Technology in Flux

The increasingly stringent water-quality standards established in the 1970s, together with the massive infusion of federal funds to help achieve these standards, resulted in one of the government's largest public-works programs. The EPA has provided more than $28 billion through its construction grants program to help municipalities build new treatment plants or improve existing facilities. Most of these plants used conventional technologies. However, the Clean Water Act of 1977 attempted to change this picture.

The act clearly established Congress' intent to encourage innovative and alternative (I/A) wastewater-treatment technologies. More attention and resources were to be directed toward developing processes with "breakthrough potential" in terms of cost reduction, reduced sludge production, improved efficiency, and conservation of resources. Natural treatment systems—including land application and aquatic systems—are ideally suited to meeting these goals.

The EPA defined "alternative" technologies as *proven* methods and "innovative" technologies as methods that advance the state-of-the-art but that have not been fully proven. Only after EPA received such explicit direction by Congress were these "recycle/reuse" technologies looked at seriously by most engineering consultants and the regulatory agencies.

Congress provided strong economic incentives through EPA's construction grants program. A city choosing an alternative or innovative technology could receive up to 85 percent funding of the costs for design and construction of the facility. A city choosing conventional treatment was originally limited to 75 percent, and recent amendments to the Clean Water Act may reduce the funding level to 55 percent or even less. Mindful of a major concern expressed by many city officials and consultants, Congress also allowed the government to pay all eligible expenses to modify or replace I/A facilities should they fail.

The government has funded EPA's construction grants program through fiscal year 1983, but what will happen after that is uncertain. For each of fiscal years 1982 and 1983, a minimum of $816 million is available nationally for I/A facilities. The total construction grants program, including funds for conventional treatment plants, amounts to $2.4 billion for each of these years.

During the program's first three years, more than 800 facilities incorporating I/A technology received federal funds. About 200 of these are "innovative," using more than 60 types of technologies for treating wastewater and managing sludge. These range from conventional systems partially powered by solar energy or heat pumps to overland-flow land treatment, wetlands systems, and aquaculture operations.

The "alternative" projects involve various land-application systems for treating wastewater, land application and composting of sludge, systems that efficiently burn sludge and recover energy, and on-site systems as alternatives to centralized collection and treatment of household wastes.

Many of the I/A projects are still under construction or in their first year of operation, but the program appears to be producing successful projects. For example, 11 of the 72 I/A projects completed in 1982 were chosen as finalists in the American Consulting Engineers Council's 1982 awards program for engineering excellence.—*R.K.B. and J.B.* □

lowers transportation costs. Once the dewatered sludge is spread on the soil surface or mixed in, natural biological systems take over, breaking down the sludge and incorporating its nutrients and organic matter into the soil.

Sludge is most commonly applied to agricultural land. Many farmers long ago discovered the benefits of participating in sludge-reuse programs—their fertilizer costs decrease, crop yields increase, and soil quality improves. For example, municipal sludge from several Ohio cities is currently being supplied to farms in neighboring counties, under the direction of the Ohio Farm Bureau and other agricultural groups. Under a grant from the U.S. Environmental Protection Agency (EPA), researchers are measuring the resulting effects on crop yields as well as monitoring human and animal health. Improvements in yields and the lack of health effects noted so far have stimulated greater interest among both farmers and county agricultural extension agents. With success stories becoming more common, farmers may someday routinely approach municipal treatment plants to *buy* sludge for use as organic fertilizer.

There is also growing interest in the potential for using sludge to increase productivity in forests and reclaim damaged lands. For example, researchers in the Pacific Northwest applied about 40 tons of sludge solids per acre to a 50-year-old stand of Douglas fir located on relatively poor soil. Two years later, they recorded a 60 percent increase in growth over untreated sites, resulting in an extra $270 worth of timber per acre. The researchers also predict that the improvement in productive capacity of these forests will last at least five years and possibly longer. Sludge can benefit intensively managed tree "plantations" as well, often dramatically. At the Savannah River Laboratory near Aiken, S.C., researchers have found that applying sludge to loblolly pines may mean that three cuttings of pulpwood—rather than the normal two cuttings—can be harvested in a 20-year period.

However, not all species of trees appear to respond equally well to sludge. Red cedar and hemlock seedlings show high mortality rates when planted on recently treated sites, while Ponderosa pine seedlings survive but their growth doesn't increase significantly. Grasses and weeds in newly clear-cut areas, as well as low-growing "understory" plants in established forests, also grow more rapidly when sludge is applied. Thus, unwanted plants may have to be controlled to reduce competition with tree growth.

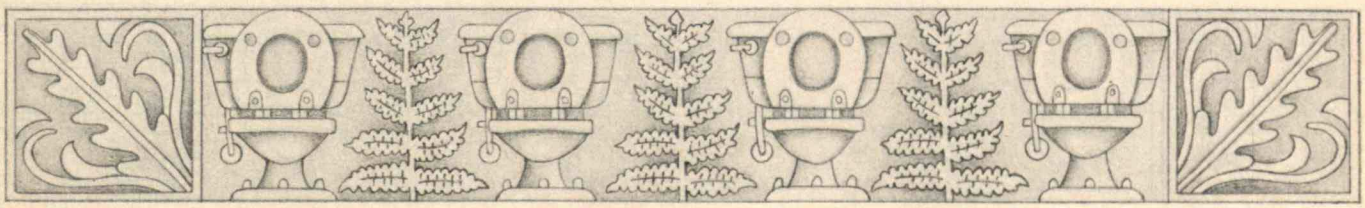
Compelled by the federal ocean dumping act to curtail disposing of sludge in the Atlantic, Philadelphia developed a master plan for managing sludge in 1975. The plan included using sludge to revegetate strip-mined lands, and the city is now reclaiming numerous spoil sites in western Pennsylvania. Because of initial opposition in mining areas, the city began with a pilot project, combined with a public-information program, to show local communities that the method was environmentally sound.

In June 1978, the state approved the application of sludge to a 10-acre barren site in Somerset County. Following grading and liming, 50 to 60 tons per acre of sludge solids were spread and mixed into the soil. The area was then seeded with a mixture of grass and legumes, and a lush green plant cover grew rapidly. Researchers monitored sludge, soil, and groundwater before, during, and after application, turning up no adverse effects on the environment. The city has since expanded the operation each year. About 1,100 acres were reclaimed in both 1981 and 1982, using nearly 140,000 tons of sludge annually.

The need for reclaiming abandoned strip mines is great—there are more than 250,000 acres of despoiled lands in Pennsylvania alone and several million acres nationwide. The costs of transporting sludge for such projects—a potential drawback—can be minimized by "backhauling" the sludge in the same trucks or railcars that bring coal from the mining areas to the city. Chicago, Birmingham, and Seattle are already using sludge to reclaim despoiled lands, while Knoxville, Pittsburgh, Tulsa, Baltimore, and several other cities are seriously considering similar sludge-management programs.

Sludge can also be put to good use at home, and one of the oldest sludge-reuse operations is run by the Los Angeles County Sanitation Districts. More than 100 tons of solids per day are composted after stabilization by digestion. The compost is then sold to a local company that screens, blends, and bags the material. The company, which has been in business for over 50 years, markets the sludge-derived product for home garden and horticultural use and to commercial nurseries. Demand is so great that the company must ration the material among selected customers.

While the benefits of recycling municipal sludge are well documented, there are also a number of concerns, especially for agricultural use. Most important is the possibility that pathogens or toxic chemicals that may be present in the sludge may contaminate



the soil. If such contaminants accumulate beyond the soil's ability to assimilate them, the land could deteriorate rather than improve, groundwater quality could be degraded, surface water could be jeopardized, and crops could become unfit for consumption.

Researchers across the country have been developing management practices to help prevent such problems. Federal and state agencies, along with a number of universities, have issued detailed guidelines on the proper use of municipal sludge as a soil conditioner and fertilizer. For example, many sludges—especially those from treatment plants in heavily industrialized areas—contain elevated levels of heavy metals such as cadmium and lead and toxic organic chemicals such as PCBs. This has prompted the EPA and many state regulatory agencies to limit the levels of such contaminants in sludges and the amount that can be applied to the land. By following these guidelines—such as applying the sludge at predetermined rates and using "clean" sludges—communities should be able to recycle municipal sludge on land safely and effectively.

Wastes Upon the Waters

Managed aquatic systems are extremely attractive alternatives to conventional methods of treating wastewater because they can clean the effluent to about the same level but often can be considerably cheaper. Managers of relatively small treatment systems, especially those handling less than 1 million gallons per day, commonly report savings of 35 to 75 percent in construction, operation and maintenance, and energy costs. Although aquatic systems can require less space than some land-treatment methods, their use by large cities may still be limited by the cost or availability of land.

Full-scale aquatic treatment systems, as well as numerous research and development projects, are operating or under construction in at least 15 states as well as in several foreign countries. These include natural and constructed wetlands; treatment ponds; systems using floating aquatic plants grown in ponds, or ditches; and aquaculture operations involving a variety of freshwater or marine organisms, often in combination with other treatment processes. Aquatic systems may employ a number of physical, chemical, and biological mechanisms to clean the wastewater, ranging from sedimentation and filtration to uptake by plants and breakdown by bacteria.

Some of the wetlands being used or investigated include cypress swamps, bogs and other peatlands, "washes" in the West that fill with water after heavy rains, and both freshwater and salt marshes. Wetlands slow the movement of surface water passing through them, which promotes deposition of suspended particles. The wetland soil, plants, and associated microorganisms assist in the cleaning. Researchers at the University of Florida and the University of Michigan, sponsored by the National Science Foundation, have provided a good scientific basis for wetland treatment in a few types of wetlands, but additional large-scale systems representing other major wetland types need to be installed in different geographical regions. Monitoring them under various conditions will provide "real world" operating information and data needed for developing reliable design criteria. Not all wetlands are good candidates for wastewater treatment—some are too valuable in their undisturbed condition, some are too sensitive to change, and some do not provide much treatment. The EPA is currently evaluating several kinds of wetlands in the Midwest and the Southeast to determine their suitability.

"Artificial" wetlands are less restricted by user conflicts and potential environmental concerns than natural wetlands. They can be constructed almost anywhere—including on lands with limited alternative uses—and they offer greater flexibility in design and operation that can lead to superior treatment and reliability. They can be built in natural settings or they may entail extensive earthmoving, constructing impermeable barriers, or building containers such as tanks or trenches. Wetland vegetation is often established on an artificial substrate such as gravel or peat. Cattails and reeds appear to be ideal plants—they are hardy and widespread, and they propagate easily and grow quickly. In Ontario, for example, an experimental cattail marsh built on heavy clay soils provides efficient year-round treatment. There is only a slight decrease in performance during the winter, when ice forms on the marsh surface but wastewater continues to flow underneath.

Shallow ponds, usually less than two meters deep, can economically treat raw wastewater or remove additional contaminants from partially treated sewage. Such "stabilization ponds" are already widely used at many treatment plants. Bacteria play the major role by decomposing the organic matter in the wastes, and algae provide oxygen for bacterial respi-

ration. Some pond systems are aerated mechanically to allow greater loadings of wastewater than could otherwise be handled.

The water hyacinth, a fast-growing, free-floating freshwater plant that is very efficient in removing nutrients and other materials, is the centerpiece in another aquatic system. About 15 acres of hyacinths, grown in ponds under controlled conditions, can treat 1 million gallons of wastewater to high levels per day. The plants take up nutrients and other chemicals as they grow, and their roots foster the growth of bacteria and higher organisms that assist in treatment. And by creating a blanket of vegetation that reduces wind and wave action on the water, they reduce unwanted growth of algae and help suspended solids settle to the bottom more quickly. Harvesting the hyacinths may be required to keep the system performing properly; 20 to 40 tons of plant material (dry weight) can be harvested per acre after about three months growth. The hyacinths can be digested to produce methane fuel or processed to produce organic soil conditioner or animal feed, but such recycling systems are not yet economical.

The use of water hyacinths was pioneered by scientists at NASA's laboratory in Bay St. Louis, Miss., where the plants have been cleaning domestic and chemical wastewaters since 1975. Systems are also being used or tested in other Southern areas, especially Florida, Texas, and California. For example, Walt Disney World near Orlando, Fla., has installed hyacinth ponds, and production of energy and soil conditioner from harvested plants is being evaluated. And San Diego is building a prototype system that will treat 1 million gallons per day, which will be used to study the potential of hyacinths for large-scale renovation of wastewater. Although hyacinths have proven effective in many locations, their use in colder climates and for treating very strong wastes is limited. The NASA researchers and other groups are now developing more versatile hybrid systems using other aquatic plants such as rushes, cattails, and reeds.

Aquaculture systems that both treat wastes and produce valuable aquatic plants and animals have potential but are farthest from widespread use. In one particularly ambitious project, scientists at Woods Hole Oceanographic Institute tested a marine "polyculture" system that used municipal wastewater. They grew marine algae in a mixture of seawater and sewage effluent, and then fed the algae to shellfish, including oysters, clams, scallops, and mussels. The algae removed nutrients from the wastewater and the shellfish removed the algae. Lobsters and fish such as flounder were then fed the wastes produced by the shellfish, and commercially valuable seaweed provided the final "polishing" of the effluent. The cost-effectiveness of the total system is questionable, but it does appear that the seaweed unit by itself may prove attractive economically.

In other projects, a variety of fish species have been grown in wastewater stabilization ponds. In Arkansas, for example, buffalofish, channel catfish, and several species of Chinese carp were raised in the last four stabilization ponds of a six-pond series in which municipal wastewater flowed from one to another. The fish got no other food. More than 3,000 pounds of fish per acre were harvested after eight months, and the quality of the water discharged from the system was improved. Another possibility is to use the cooling water discharged from power plants and industrial boilers, combined with various agricultural and industrial wastes, to support a commercial aquaculture system. Public utilities in at least ten states are exploring this prospect. However, it appears that aquaculture systems cannot be optimized for both food production and waste treatment in the same unit; systems involving higher forms of animals seem less efficient at treating wastewater and are more difficult to manage. But in some cases it should be possible to combine waste treatment with aquaculture systems to help decrease net costs.

What's Needed for Success?

Several problems stand in the way of widespread acceptance of natural treatment systems. Many natural areas have traditionally served as convenient sites for disposing of wastes, leading to serious environmental problems. Thus, many people automatically oppose integrating natural systems and waste-treatment projects. Also, adjoining landowners, government officials, and special-interest groups often express concern about potential odors, aesthetic problems, noise, and property values. And people often differ widely in their views about land use—such as whether to allow multiple use of public lands or how to balance environmental protection and development. Education in the form of public meetings and information campaigns is the way that many successful programs have approached community relations. Letting people know and see what to expect—

the disadvantages as well as the advantages—helps gain public acceptance.

Even more important, researchers are still uncertain about the eventual fate and long-term impact of some contaminants in wastewater and sludge. The possibility that heavy metals, toxic organic chemicals, or disease-causing organisms may become concentrated in food chains, flow into local streams, or leach into groundwater supplies cannot be ignored. Nor can the potential for disease outbreaks and worker contamination caused by poor management or simple miscalculation—issues often raised when natural treatment systems are proposed. Research continues in these areas but needs more emphasis. However, natural treatment systems should not be singled out as having ecological problems; conventional treatment facilities release the same materials, merely to different ecosystems. In assessing natural treatment, environmental effects should be compared to those of available alternatives and not to "zero risk."

Good project design and management is the key. And appropriate siting and thorough monitoring will go far toward assuring both scientific and public confidence in these systems. Most, if not all, environmental problems can be avoided or mitigated by using proper management controls. For example, sludges can be treated to stabilize odor-causing organic materials and to reduce pathogens and toxic chemicals to acceptable levels. Wastewater and sludge can also be applied according to crop needs, weather conditions, and waste-production rates. And pretreating industrial wastes before they are put into the sewer system should greatly reduce contaminant concentrations in the effluent and sludge produced at many municipal treatment plants.

Appropriate regulations and guidelines are also essential. These should allow a measure of flexibility that reflects how a system is used. Designers and managers of systems devoted primarily to sewage treatment—where the public has few opportunities to come into direct contact with waste—should have greater leeway in choosing application rates, pretreatment, and other procedures to hold down costs. For example, California's Department of Health has long allowed different uses of wastewater that has received different levels of treatment and disinfection. The degree of treatment required is tailored to the specific use: for example, whether it's for use on cropland, golf courses, or highway medians. Many states have also adopted regulations or guidelines for the controlled use of sludge in agriculture, and some have guidelines for forestry and land reclamation.

The purpose of a natural treatment system must be clarified early in the planning stage. Projects can be designed and operated solely for waste treatment and disposal or to achieve multiple benefits, including crop production, water conservation, and the like. The choice will determine how to balance technology and operations, costs and benefits. For example, if obtaining multiple benefits is the goal, project costs may be higher because more land and equipment is needed, application rates may be lower, and pretreatment may be more thorough. But under the right conditions, the value of marketed products or other benefits can offset such additional costs. On the other hand, if waste treatment is the only goal, simplified natural systems that cost less but don't provide other benefits may be more appropriate.

There are also a variety of more practical problems. Building all the components of a system—transmission lines, dikes, weirs, impoundments, storage facilities, access routes, and monitoring stations—without seriously disrupting natural areas can be difficult and expensive. This is especially true in wetlands and forests. And many sanitary engineers and public officials simply prefer dealing with established technologies for treating wastes. Despite recent government efforts to encourage use of innovative technologies, such as the EPA's construction grants program, few consulting engineers and equipment manufacturers have expressed interest. This is not entirely surprising. Natural systems require less equipment and feature simple engineering designs, so profit opportunities, at least in the short term, are not enormous. Natural treatment systems will be accepted slowly unless government agencies aggressively promote their development and use.

Sewage disposal is a complex task: done improperly, it can adversely affect the air, land, water, and ultimately, people. We must be careful not to simply shift the problem from one environmental medium to another. But properly managed natural ecosystems, although no panacea, do offer an ecologically acceptable way to deal with pressing water-pollution problems at reasonable cost.

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A Tale of Two Cities

SALEM, Ore., is an important food-processing center. This means that the city faces periodic increases in the amount of sewage that needs treatment—up to six-fold more during the peak months of canning and freezing operations.

In the past, the city expanded its wastewater-treatment capacity to keep up with both population growth and seasonal surges. But this didn't solve the problem of what to do with growing quantities of sludge, the solid material removed during treatment. Storage lagoons were the answer until 1968, when the lagoons came within a few years of reaching capacity.

The city then began to haul sludge, rich in important nutrients and organic matter, to local farms for use as a soil conditioner and fertilizer. Unfortunately, deliveries were often irregular because the 1,400-gallon tank truck tended to get stuck during the long rainy season. It also gouged deep ruts in the fields.

Complicating matters even more, local residents began to blame the disposal operation for odors—mistakenly, since the odors came from the spreading of livestock manure. It soon became difficult to find farmers willing to use the sludge, leading Salem to reorganize its system.

The Birth of Biogro

The first step was to develop a trade name and catchy logo for the sludge. Salem then set about promoting its "new" product—Biogro. The city appointed a manager who was familiar with local farming and could help farmers make the best use of Biogro. Potential users were informed about the program through meetings and promotional brochures, and care was taken to gather farmers' comments about their needs.

Salem's treatment plant handles an average of 28 million gallons of wastewater per day. Its sludge is well suited to farm use because of the large input of organic food-processing wastes and the absence of many other industrial wastes that might contain toxic chemicals. The result is approximately 7,800 tons per year of Biogro, which is in liquid form containing 2 to 3 percent solid material.

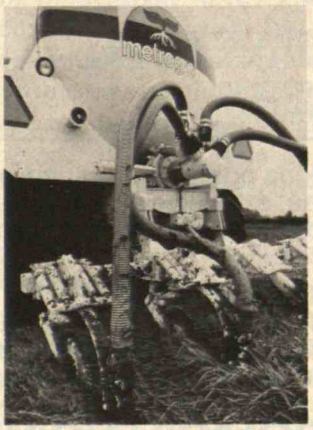
Transportation and application of Biogro were also improved as part of the new program. Several 2,500-gallon "spreaders"—trucks equipped with special flotation tires to prevent gouging and compacting of the soil—are now used. These spreaders, easily identified by the Biogro logo, spray a 10-foot to 30-foot-wide swath.

Five tankloads are usually needed to supply the equivalent of two tons of dry sludge per acre, the amount considered best for promoting plant growth. It costs the city just over $51 to provide one ton of Biogro.

Biogro is now spread on about 2,000 acres of cropland, and demand is growing. Regular monitoring, following state regulations and guidelines, is an integral part of the program. After five years of testing sludge, soils, crops, and groundwater, researchers have found no harmful effects. And farmers are enthusiastic—Gary Clark calls Biogro "an excellent supplement to commercial fertilizer."

To avoid the problems caused by muddy fields, the city now limits delivery to the dry season. Therefore, Biogro produced during the rainy months must be stored. During ordinary preparation of Biogro, the sludge is "stabilized." This is done by a process called anaerobic "digestion," in which bacteria decompose odor-causing materials. The digestion system also provides 60 days of storage capacity, and several lagoons provide an additional 100 days of emergency storage.

Public-information programs have played an important role in gaining acceptance of Biogro, especially concerning the odor "problems." Local residents now know that Biogro smells much like tar or used engine oil, not like sewage or animal manure. This smell disappears rapidly after application, and can be eliminated even faster by plowing the sludge into the soil.



Metrogro in Madison, Wisc. Once sludge is applied by spraying or injection into the ground, natural biological systems break down the sludge and incorporate its nutrients and organic matter into the soil.

Metrogro in Madison

In Madison, Wisc., sludge reuse dates back to the early 1930s, when the city sold or gave stabilized dry sludge to residents for fertilizing lawns and gardens. However, the shortage of workers during World War II forced the city to switch to low-maintenance storage lagoons that were less expensive to operate.

Then in the early 1970s, dikes in the storage lagoons began to break, convincing the city that it needed a more reliable method of sludge disposal. City officials studied various methods and concluded that applying the sludge on farmlands would be the most practical, economical, and environmentally sound.

Madison is about twice the size of Salem, and its wastewater-treatment plant handles about 35 million gallons per day. Almost 15 percent of the wastes come from meat-processing companies, so the sludge is rich in nutrients, minerals, and organic material. The plant generates about 5,500 tons of stabilized sludge—which the city has named Metrogro—per year.

Metrogro is transported to local farms in 3,500-gallon truck spreaders, which spray the sludge on the surface or inject it into the soil. But even

equipped with flotation tires, the spreaders do not work well on the wet or soft soil common during late spring and early fall. Nor is the sludge spread during the winter, when the ground can freeze to a depth of 20 inches.

This means sludge must be stored for even longer than in Salem. After being stabilized by anaerobic digestion, the sludge is put into renovated storage lagoons. These already contain about 100,000 tons of sludge produced prior to the new program.

City officials have adopted a 10-year plan, with 10,000 tons of sludge per year being distributed to farms located within 10 miles of the treatment plant. As the program expands and the lagoons are cleaned out, the city's expenses for sludge disposal should be cut in half by decreased operating costs, equipment needs, and personnel requirements.

Farmers in the program already talk of its benefits. For example, Bob and Fred Uphoff, who grow corn on 124 acres, say: "During the past several years, we've found that Metrogro has greatly improved the texture and water-holding capacity of the soil. It's also a good source of nitrogen. We feel fortunate to have access to this good organic fertilizer."

Madison supplies all of the labor and equipment used in the program, and the annual cost runs to about $120,000. The return on this investment of time, planning, and money is a program that works—one that links city and farm in the cycle of nature.—*R.K.B.* □

Designers and Engineers: Strange but Essential Bedfellows

BY RALPH CAPLAN

RODGERS and Hammerstein's musical *Oklahoma* presented a classic confrontation between two interest groups—farmers and cowboys—for control of the same turf. Engineers and industrial designers often find themselves in a comparable conflict. Although this too will pass—the Oklahoma territory eventually became a state and farmers and cowboys became part of the same economy—in the meantime the strained designer-engineer relationship diminishes productivity and product quality.

"Our basic quality problem," says an executive for an industrial-equipment company, "is that our designers and engineers can never get together. The engineer sees the product from the standpoint of function. The designer sees it from the standpoint of ergonomics [that is, human factors] and esthetics. The engineer thinks, 'If the designer had just let us put this bolt out here where we wanted to, it would hold.' The designer thinks, 'It's hard to believe that a company concerned about quality would be willing to let anything go out the door like this.' "

How did things get this way, and why? It helps to look at industrial design and its origins.

Where Do Designers Come From?

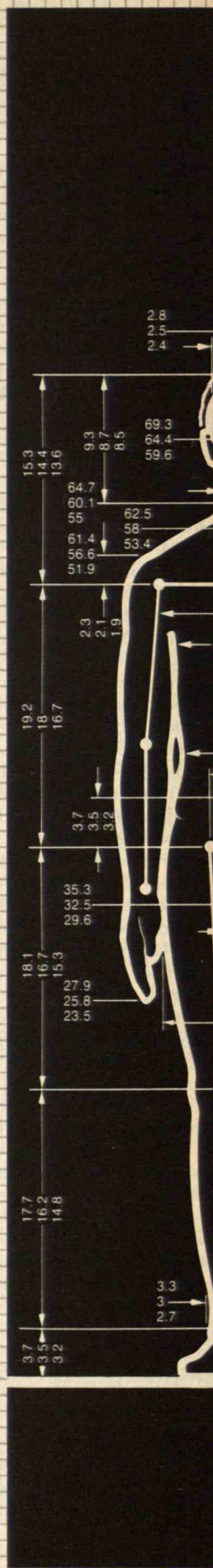
Industrial design is the process of shaping goods to be made by mass production—except that many products of industrial design are not mass produced. Industrial design is a plan for arranging the elements of a product to accomplish a particular purpose—but so is a concerto. Design is the communication of the function and quality of an object, as well as the character and integrity of its makers, by visual, nonverbal means. But before quality can be communicated, it has to be designed into the product.

And so on. There are hundreds of definitions, many of them good, none of them adequate. Although it may seem like going around in circles to say so, industrial design really is the process of designing what industry makes. Of course, the products industry makes are "designed" whether industrial designers are involved or not. Their contribution is to better relate the product to the people who will use it.

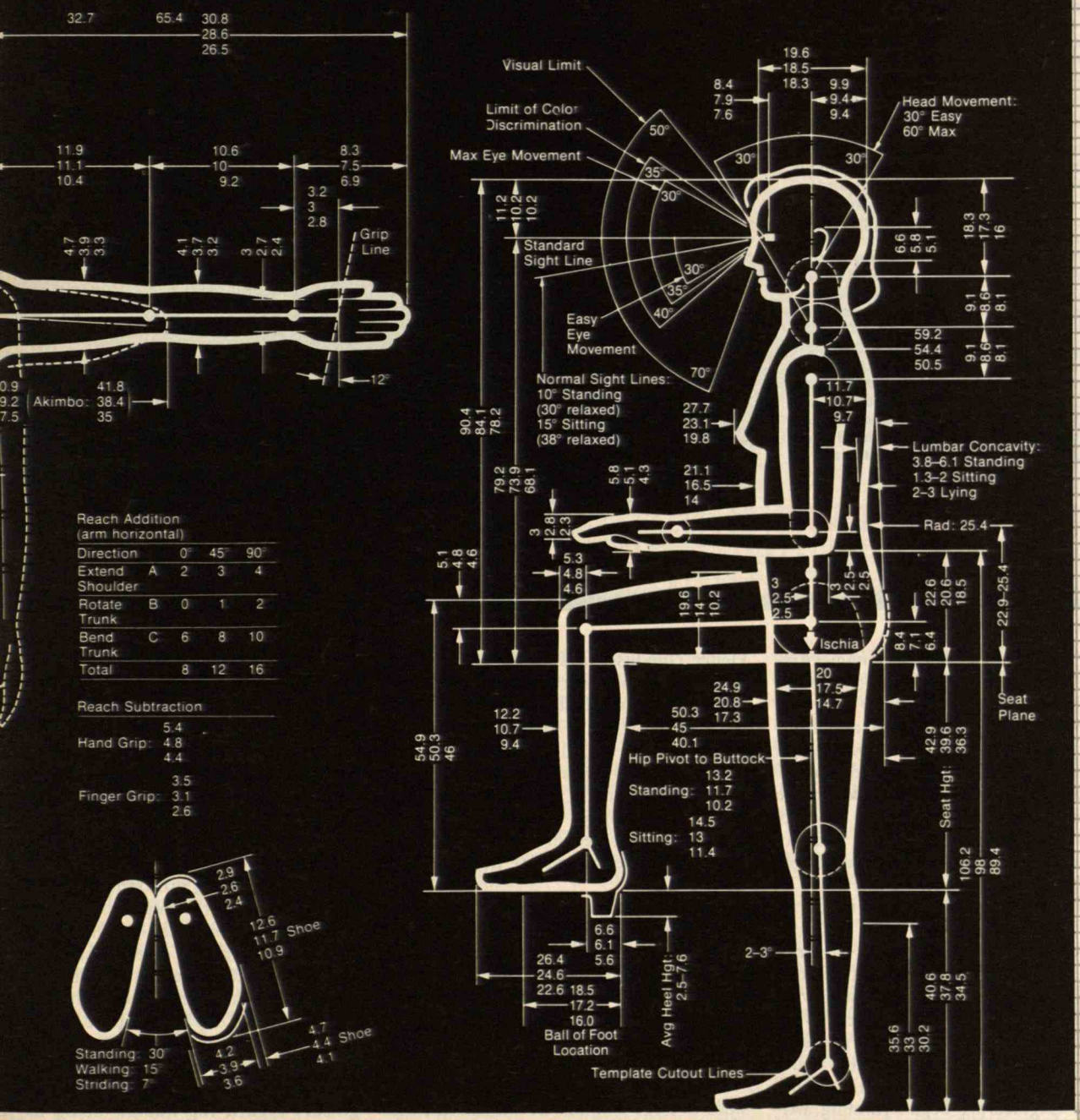
The designer is presumably qualified to do this on the basis of talent and training, but the appropriate training, like the discipline, is not easy to categorize. There is no mystery about where engineers come from: engineering schools. But industrial designers may come from anywhere, and historically they do. The earliest industrial designers in America were first stage designers, fashion illustrators, and book decorators, so it is not surprising that they brought to their industrial work a point of view that engineers found suspect.

In *Twentieth Century Limited*, Jeffrey

RALPH CAPLAN, formerly editor of *Industrial Design* magazine, is a writer and communication-design consultant in New York. This is adapted from his book *By Design* (St. Martin's Press, 1982).



Human factors.
To make products "user-friendly," designers and engineers can draw upon schematics like these produced by Henry Dreyfuss Associates. The measurements portray the large, average, and small man and woman.

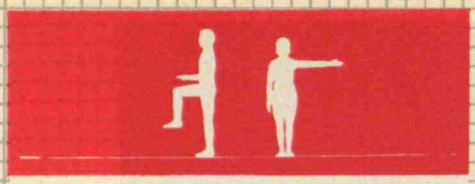


Reach Addition (arm horizontal)				
Direction		0°	45°	90°
Extend Shoulder	A	2	3	4
Rotate Trunk	B	0	1	2
Bend Trunk	C	6	8	10
Total		8	12	16

Reach Subtraction

Hand Grip: 5.4 / 4.8 / 4.4

Finger Grip: 3.5 / 3.1 / 2.6



1 Testing comfort. Hundreds of probes within the cushions measure body contours under various conditions. Niels Diffrient used such a device in designing this airplane chair, 2 incorporating new comfort principles, for American Airlines.

3 More than a seat. This is Diffrient's sketch of his chair that fits body contours, allows free movement, and looks elegant. Pleasure from a product's appearance is important; when asked whether he designed for pleasure or function, Charles Eames, a pioneering U.S. designer, replied, "Whoever said pleasure wasn't functional?"

4 and 5 Designer electricity. Diffrient worked closely with engineers – "since the structure *was* the product" – to redesign high-voltage towers for Southern California Edison Co. Designers can often help engineers with the "human" side of technology.

6 Tailor-made laboratory. Since projects start and stop and people vary in size and habits, components in this "Action Lab," designed by Herman Miller, Inc., can be adjusted and rearranged accordingly. To satisfy technical needs, components resist heat and chemicals and have seamless surfaces and rounded edges to prevent buildup of dirt and bacteria.

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Meikle describes the designer-engineer relationship of the early 1930s—in other words, about as soon as there was one. Pinpointing 1933 and 1934 as "transitional years," when industrial design was changing from a suspect fad to common practice, he says, "The hardest battle in selling industrial design [was] convincing veterans of manufacturers' product design departments that industrial designers were not . . . 'interlopers invading an area sacrosanct to the engineering mind.' "

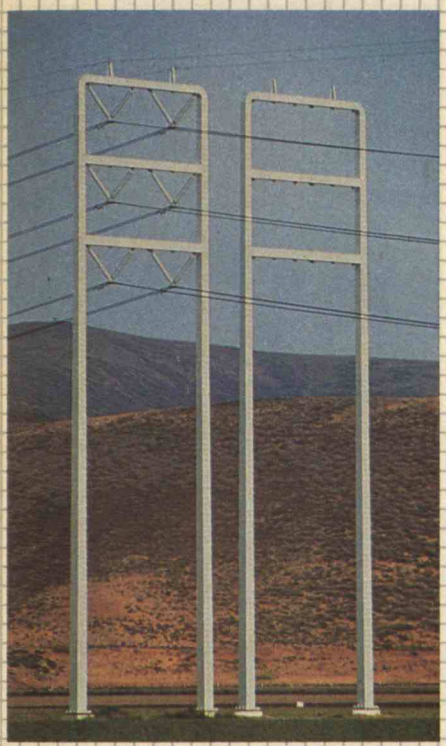
Meikle also points out that in those job-scarce years, engineers were not likely to look with favor on anyone who threatened their jobs. This led them to resist design as frivolous and—just in case it wasn't—to take a grudging interest in design themselves. The trade magazine *Product Engineering* began running articles on the importance of color and expressiveness.

But although engineers may see color, form, comfort, and convenience as necessary evils, designers see them as intrinsic to what they are doing for the end user. Henry Dreyfuss—a pioneer American industrial designer—wrote this as his credo: "We bear in mind that the object being worked on is going to be ridden in, sat upon, looked at, talked into, activated, operated, or in some other way used by people, individually or en masse. When the point of contact between the product and the people becomes a point of friction, then the industrial designer has failed."

There is nothing terribly profound about these aims. But compare that statement with this excerpt from an engineering textbook on design reliability: "A number of systems require operation by a human, who thereby becomes an integral part of the system and, as such, can have significant effect on system reliability. Obviously, then, the designer must consider a large number of human factors. For example, he must not schedule the operator to (1) exceed his physical strength, (2) perform too many functions simultaneously, (3) perceive and process more information than feasible, (4) perform meticulous tasks under difficult environmental conditions, (5) work at peak performance for long periods, (6) work with tools in cramped quarters, etc. The aim of the designer is to maintain maximum system reliability by keeping the operation as simple as possible. Yet, no matter how well a product or system is designed and constructed, its ultimate performance is subject to human factors, e.g., carelessness."

There is nothing profound about these aims either, but the implication is vastly different and somewhat chilling.

Granted, both are extreme statements. Few industrial designers marshall their energies around such purely humane considerations as Dreyfuss proposed. For one thing, they are retained by clients who stress above all that the object being worked on is to be *sold*. And few engineers regard the human being as so purely objective a component in the system as the author of the engineering text suggests. But the difference in emphasis between the two passages is worth noting. Designers see the end user as the person to be satisfied, and satisfaction means more



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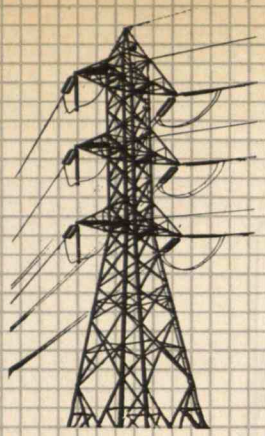

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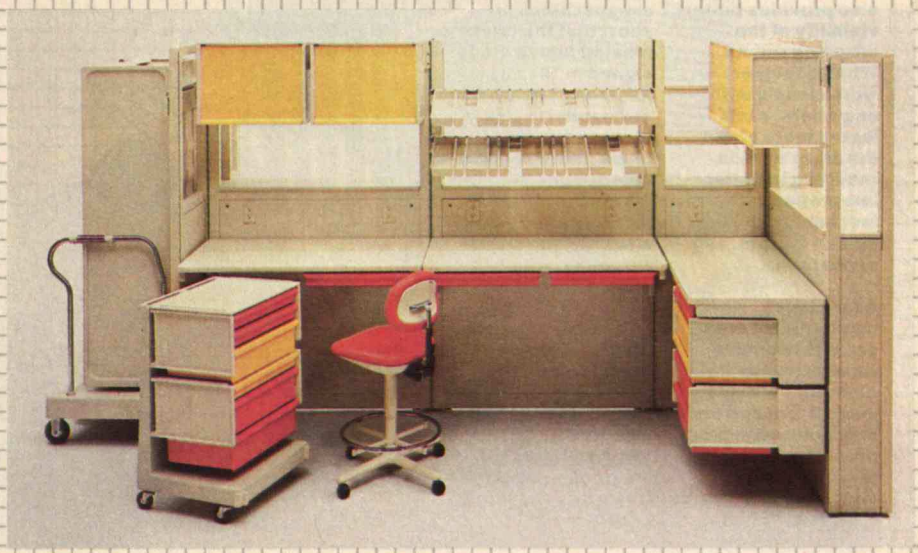

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than maximum system reliability. When asked whether he designed for pleasure or function, Charles Eames, one of America's truly significant designers, replied, "Whoever said pleasure wasn't functional?"

Professional Epithets

The first generation of American industrial designers was used largely as facelifters, their role to invest products with superficial sales appeal. But during World War II, when defense products replaced consumer products, designers were used more seriously—perhaps because people take war even more seriously than they do business. For example, the layout of an airplane's cockpit panel or a field radio transmitter is more critical than that of an automobile and table radio. According to industrial-design historian Arthur Pulos, "The designer learned to work for engineers, where before the war he had worked primarily for salesmen."

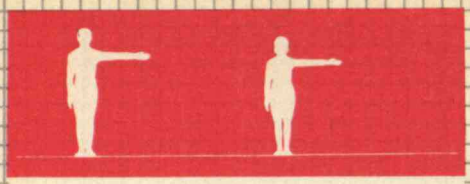
More importantly, designers learned to work *with* engineers, although they did not always learn to work with them very well. The designer-engineer relationship is shot through with misunderstanding, seeming conflict of interest, and just plain petty backbiting. Presumably the joint interest in the final product calls for intense collaboration, with each one bringing expertise to the problem. But to say just that is like singing "the farmer and the cowman should be friends." Rodgers and Hammerstein were right about that, but the end of the lyric was not the end of the feud.

Even at its most superficial, as in "styling," design affects a great many products. The same designer may very well be responsible for a mechanical walnut cracker and an electrical circuit breaker, but what does "responsible" mean? Although designers may determine the final appearance of those objects, their general appearance—as well as their very existence—is determined by engineers. Or so it looks to engineers.

According to the myth prevailing among engineers, designers are all gloss, stylists equipped by temperament and training to do nothing more than frost the bread of life so it can be sold as cake. They are the cowboys, dashing on palominos, dazzling with rope tricks, addicted to boasting, showing off, and buying tax-deductible drinks for everybody. Their guitars attract the attention of management, but their high-heeled boots are impractical for walking on solid ground.

Well, that *is* true of some industrial designers and used to be true of a lot more of them. But when they confront engineers, designers tend to be damned if they do and damned if they don't. If their contributions are merely styling, designers come across as parasites living off the organic health of engineering. However, if they contribute to structure and function, they are accused of stealing the birthright of professional engineers.

On the other hand, consider mythical engineers as seen by industrial designers. Narrow and uncreative, engineers are highly trained mechanics, congenitally unable to view a product in any context larger than the working of its parts. They are wholly oblivious to the requirements of marketing, use, convenience, and ap-

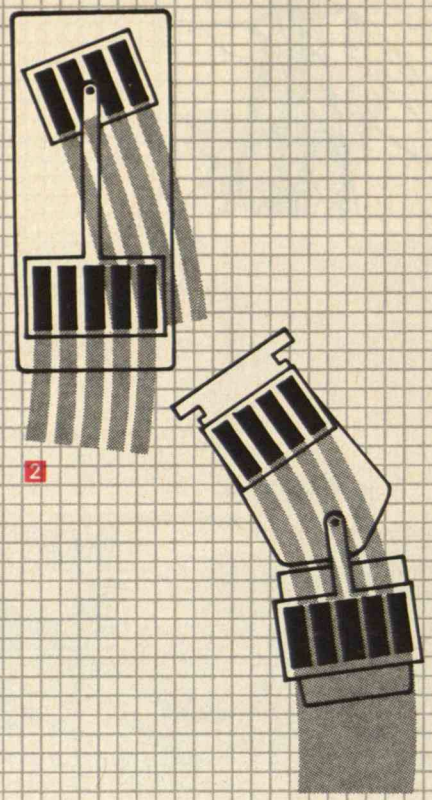


1 Redesigned rollers. By "breaking" this highway compactor in two, Diffrient improved its performance. Placing the operator's seat in the middle also provides better visibility of the vibrating drums. When designers work closely with engineers, each learns more about the other's skills—resulting in better integration of mechanical design, human factors, and appearance.

A new twist. 2 In conventional compactors the front drum provides the steering—but this keeps front and back drums from tracking properly during turns. The redesigned compactor 3 with its "pivoting action" in the center allows the drums to follow the same path.

This early Caterpillar 4 tractor was uncomfortable to operate and its exhaust stack so short that the driver inhaled fumes. Redesigned in 1942 by Raymond Loewy, the new model 5 had higher exhaust pipes, more comfortable seating, and was easier to operate. The sides were also simplified and made smoother, which improved maintenance.

All photos courtesy of: Niels Diffrient; *Humanscale* by Henry Drefuss Associates; Herman Miller, Inc.; Hyster Co.; *Industrial Design* magazine; *Industrial Design* by Raymond Loewy.



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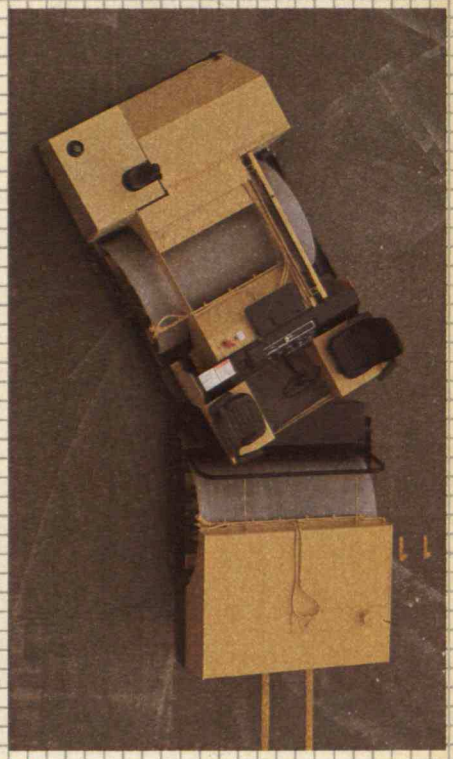

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pearance. They are farmers: solid, stable, and square, but so set on plowing a deep, straight furrow that they can't see the world on either side.

Some engineers are like that, but they are also damned if they do or don't. Industrial designers begin to resent them the moment they become concerned with the very things the designers complain that the engineers don't care about. The plain truth is that even if appearance were the only criterion, engineers have a better record than designers. As art critic Sheldon Cheney observed, "The machinery in the power house has a potent line-and-form fascination that anyone alive to art must feel." Certainly some of the most stunning examples of twentieth-century design are technological products that have had no design treatment as such.

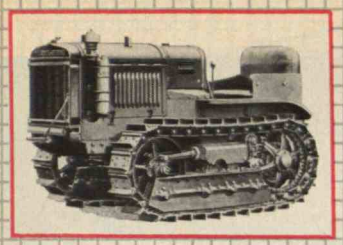
Complementary Opposites

Don McFarland, who is trained both as an aeronautical engineer and an industrial designer, describes an interesting difference in the two operating styles. Engineers, according to McFarland, customarily work from the inside out. That is, they are trained to solve problems by thinking first in terms of technical details. But industrial designers normally work from the outside in. They start with the complete product as it would be used by someone and work backward into the details required to make the concept work. To engineers this may seem like beginning at the end, and in a way it is. Paradoxically, this backward way of working explains why it is important for designers to be involved in a project at the very beginning: if they are called in after the details have been worked out, there is not enough room to develop a concept responsible to users' needs.

The two very different approaches have to do with two very different roles. They can be usefully oversimplified in the following way. Let us suppose that the product being developed is an electric fan. Engineers are charged with seeing that the fan will work. Industrial designers are charged with seeing that someone will—and conveniently can—work the fan. This represents a world of difference in emphasis. The engineers' main concerns have to do with the interaction of components and materials. Their job is to develop the best product consistent with the state of technology and the anticipated market price. The designers' job is to make sure that the product is one that will be bought and used—not, one hopes, in that order of importance, but usually in that sequence.

Yet to put it that way makes it sound as though these are discrete steps in an assembly line of creative thought, with engineers completing phase one and then turning the job over to designers for polishing. Design in such a case would be simply laid on—"applied art" in the worst sense. A lot of products are "designed" in this wasteful way. But a product, like a person, can have no integrity as a split personality, and engineers and designers must work with one another. Design must be done within constraints and engineers know what the technical constraints are. (Unfortunately, they may see constraints under every bed.)

Even within a given set of constraints,



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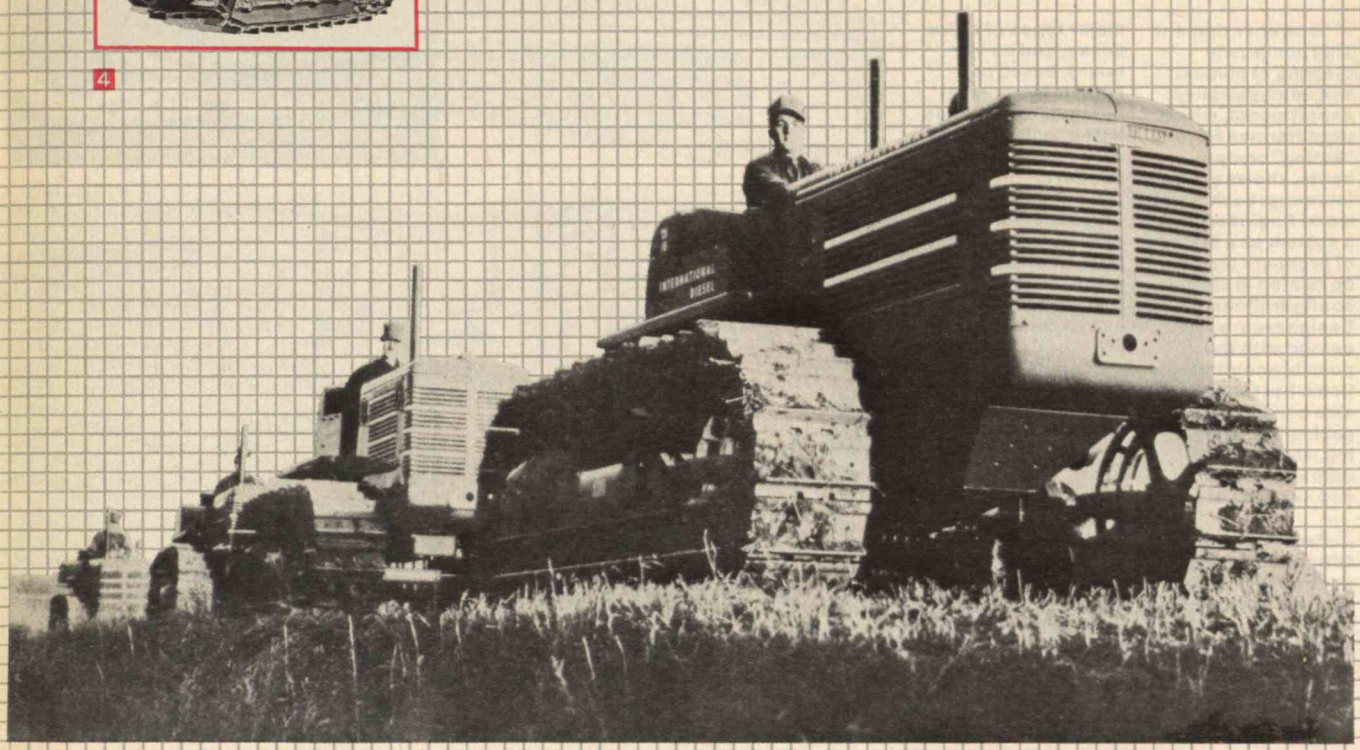

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various approaches are possible. For example, if the product were a toaster, designers might take one of the following routes:

☐ Styling. This is essentially packaging, and the designer's role is to house the heating mechanism in a more appealing case.

☐ Another designer may go further, rearranging the mechanism to increase heating efficiency or reduce size.

☐ A third designer may begin with the heating mechanism and redesign *it*.

☐ Still another might (and did) study end use and, noticing that white sliced bread has become the comestible of last resort for many people, design a toaster that will accept bagels, bialys, scones, and *pain au chocolat*.

☐ Another designer, seeing that most homes already have an oven, might devise something to make oven toasting as convenient as pop-up toasting.

☐ An even more rebellious designer might work on a way to treat bread chemically so that it toasts itself upon being unwrapped.

These approaches are arranged in order of decreasing probability. The first, alas, is what most designers would be expected to do for most clients, and the last is what no one would be expected to do for anyone. But all approaches require that the designer learn some of what the engineer already knows.

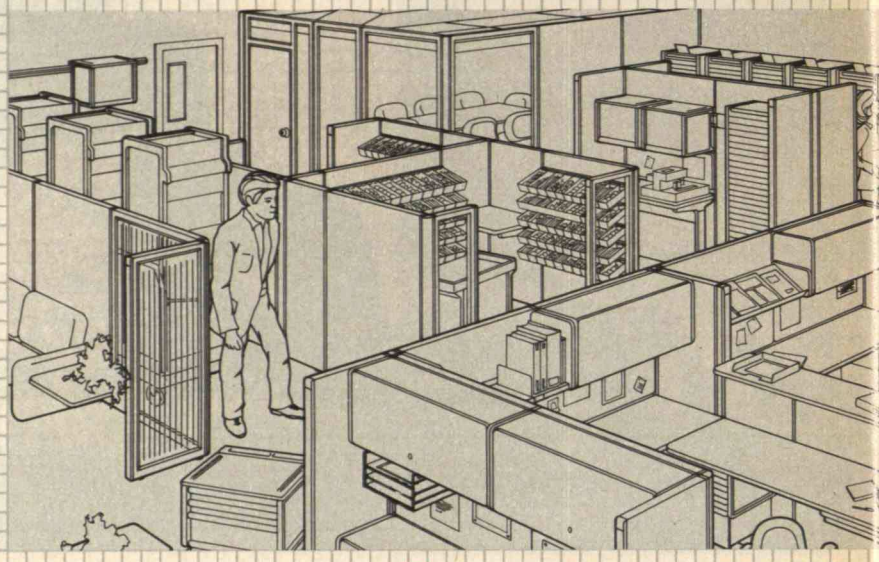
Interdisciplinary Design

In fact, designers often appear to engineers to be technically ignorant. In many cases this is not a matter of appearance; it *is* ignorance, but ignorance that can supplement the technical knowledge and specialized skills of engineers. It is neither necessary nor desirable that all members of a manufacturing team know the same things. A little technical misunderstanding can do a power of good.

A case in point is Niels Diffrient, an industrial designer widely experienced in working for highly technological industries. When he started as a consultant with the Hyster Co. in 1955, one of Diffrient's first tasks was to redesign a line of lift trucks, a matter of simplifying the form of a complex machine. He quickly realized that to serve the client satisfactorily, he would have to learn what engineers do in more detail than his design training had provided. This entailed doing his design work in the Hyster plant with the company's engineers. The more Diffrient learned about engineering, the more the engineers learned about design; the result was better integration of mechanical design, human factors, and appearance.

Diffrient also recalls the redesign of a device for rolling out the pavement material in highways. In the traditional engineering approach, the device had a front roller that pivoted to provide steering. But this kept the front and back rollers from tracking properly during turns. Working closely with engineers, the designer divided the vehicle in two, with a pivoting action placed at the center, allowing front and back rollers to follow the same paths. Instead of being steered like a car, the vehicle twists like a caterpillar, a functional improvement that uniquely enhances appearance as well.

2



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1 Total environment. This composite drawing of clinical and administrative departments, which uses Herman Miller "Action" components, shows a "systems approach" at work. Engineers see a system as a series of products that can be related in various configurations. Designers are concerned with those possible configurations, but they are also concerned with packaging, marketing, and above all, operation by users and *systems* of users.

2 Part of a whole. Office components, such as this Hewlett Packard computer terminal, must fit into larger systems as well as have their own good design. This unit fits all major types of office desks, and its keyboard, based on human-factor measurements, provides better legibility, comprehension, and user comfort.

Cleaner creamers. 3 Cream separators were hard to keep clean because of their many recesses and exposed areas. Raymond Loewy redesigned this machine in 1945, which not only provides impeccable cleanliness but features "clean" appearance as well.

5 The Pennsy K4S, a streamlined design by Loewy. After its contours were refined in wind-tunnel tests, it was built in 1937 as the S-1 locomotive for the Pennsylvania Railroad.

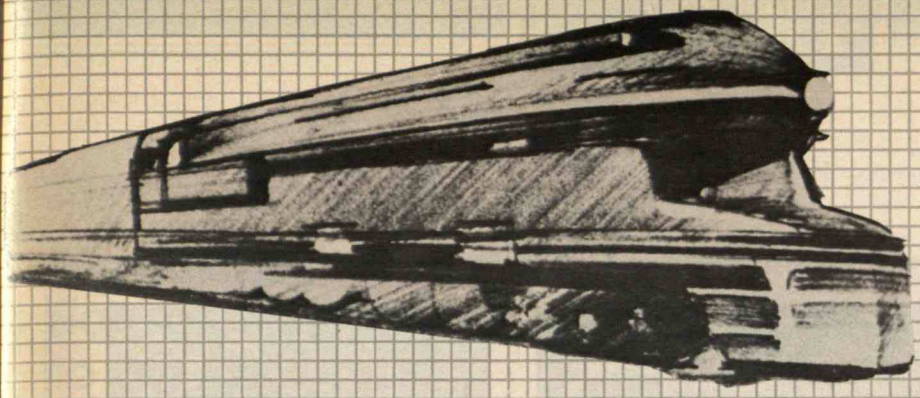
Sometimes the engineer joins the design team rather than vice-versa. For the design of high-voltage towers in California, Diffrient hired an engineer to work with the designers because "in that case the structure *was* the product." There is a strong historical precedent for this. In the 1920s, the Standard Gas Equipment Corp. commissioned industrial designer Norman Bel Geddes to design a new stove. His primary assignment was to make it look more appealing, at the time the standard motive for calling in a designer. But his first move was to assign an engineer from his own staff to work with the company engineers. In the end, hundreds of stove components were reduced to 16 basic modules.

It is not uncommon for designers to be called upon for superficial help and—in the course of enhancing appearance—to contribute far more. The English designer James Pilditch cites the case of an Eveready flashlight that was to be "styled" to increase sales. But it turned out that styling was not the solution and sales were not the only problem. The polished plastic surface of the existing flashlight made even the slightest imperfection highly visible, causing a high reject rate by quality control. The designers also discovered that the thickness of the mold used to produce the flashlight varied, so that some parts of the plastic took longer to cool than others, which led to production delays. Collaborating with product engineers, the designers gave the flashlight a textured surface, which simultaneously made it easier to grip and less vulnerable to hairline flaws. And by specifying uniform wall thickness for the manufacturing mold, they were able to simplify and accelerate production.

Obviously, the models for interdisciplinary design vary a good deal. In the case of appliances and other consumer goods, engineers and designers may work so closely together that afterward neither group will be able to say clearly who did what. In the case of a computer system, however, the mathematicians responsible for the information theory, and the engineers responsible for translating this into working electronics, have roles very far removed from that of the designers, who are responsible for organizing the console and color of the panels.

In design—as in engineering—the emphasis on product is increasingly giving way to an emphasis on system. Because a "systems approach" reflects the part of our culture that began with Henry Ford, it has found its way into design and manufacturing generally. Or at least into the jargon: "system" sounds more complicated and demanding than "product." For example, one manufacturer describes the rain hat it makes as "not just a hat but a headwear system." An interior designer describes the layout of space in an office building: "It isn't an internal design problem at all—it is a mini-urban systems problem."

Despite the abuse of language in some instances, a systems approach is legitimate. Office furnishings, factory machinery, and photographic equipment are examples. The designed products are less likely to be discrete objects such as desks, lathes, and cameras than systems that include those and other objects. But the two



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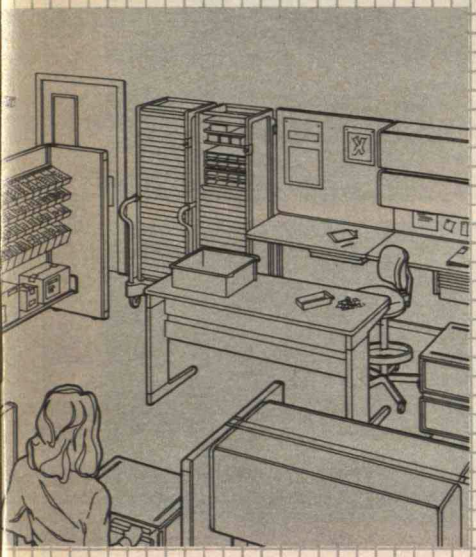

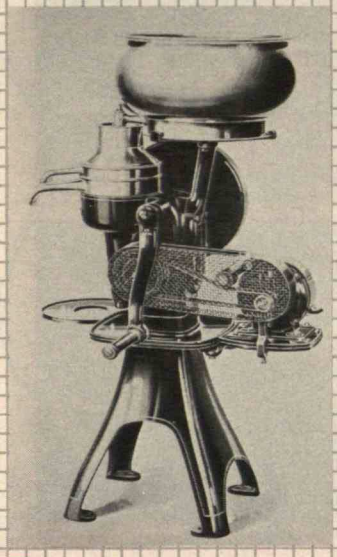

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disciplines differ here too. Engineers must see a system as a series of products and components that can be related in various configurations. Designers are concerned with those possible configurations, but they are also concerned with the related systems of graphics, packaging, marketing, and above all, operation by users and *systems* of users.

Not by Farmers Alone

Whatever the project, stereotyping makes strange bedfellows seem stranger than they really are. Designers, like engineers, are insatiably curious about how things work. Engineers, like designers, are attracted to some forms simply because they are nicer than others. I suspect that if design and engineering are to be integrated, it will not be through having designers master high technology or engineers study theories of form, but by exposing members of both disciplines to the humanities.

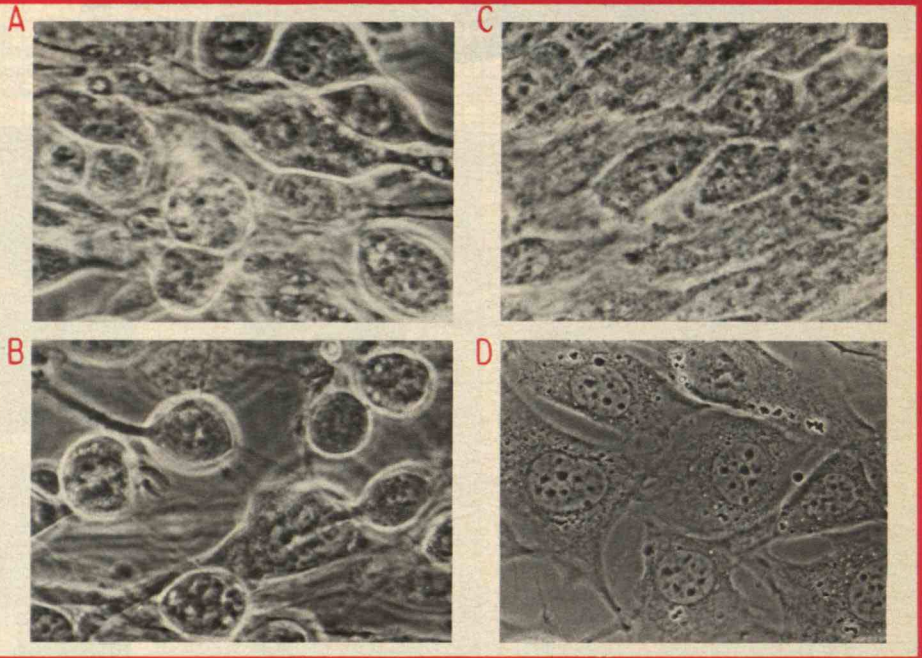
More generally, the hope for integration lies with individual engineers who are genuinely concerned with the human uses of what they make (including appearance, the use of which is to look at); with industrial designers who know that materials, methods, and structure are as important as a clean line; and with corporate leaders who understand the role of the design process in corporate life. For without the support of top management, no integrated program of design and engineering will succeed. Companies whose engineers take industrial design seriously—IBM, Olivetti, Bang & Olafsen, and Hewlett-Packard, among others—are invariably those whose managers take it seriously.

What can managers actually do to improve working relationships between designers and engineers? They can give both parties access to essential information and to each other. Designers should be involved very early in a project because their chief contribution may come before the problem is defined. Similarly, engineers need to know marketing objectives because they may impinge upon their work in unpredictable ways, and because they will help make the designers' efforts understandable.

Managers, including design managers, also need to become more sensitive to crediting. Engineers are understandably incensed when they are not given credit for the design aspect of their work, which is, after all, basic.

Of course, there is no formula for success. Like so much else, most of what can be done falls under the rubric of communication. The engineer-designer relationship is just that—a human relationship and therefore dependent upon trust. In this the designer has more experience. Whether consultant or in-house, designers have had to master professional relationships because they can do so little alone. Designers are accustomed to being misunderstood and distrusted, to ambiguity about what they do and skepticism about whether it needs to be done. Yet now that manufacturers worry increasingly about how to make their products "user friendly," they and their engineers need help with the human side of technology. Designers can help them. The West, after all, could never have been settled by farmers alone. □

Code for Cancer



A few years ago scientists discovered a gene that produces cancer when inserted into human cells. Photomicrographs A and B show human bladder cells infected with this gene; C and D show the same cells with a normal gene inserted. Scientists recently have found that the only difference between the normal and the cancer-causing gene is a minute change in just one of the 6,000 nucleotides inside each. (Photos courtesy of *Nature* magazine.)

In the tightly coiled molecule of DNA in each human cell, there are 100,000 genes, each carrying the instructions to produce a single body protein. Inside each gene 6,000 nucleotides contain the basic chemical letters of life.

Researchers have recently discovered that in at least some cases, the only difference between a normal gene and one that codes for cancer is a minute change in just one of these nucleotides. Their finding—that the awesome disease of cancer can start with the simplest mutation possible—is the talk of the scientific world.

"It's like night and day in our understanding of the basic molecular structures of cancer," explains Robert A. Weinberg, the M.I.T. professor who headed one of two scientific groups that made the discovery. "We've never known the molecular basis of cancer. Now we're at the heart of things."

Five years ago, scientists didn't even know there was such a thing as a human cancer gene. But in 1980, Weinberg and Geoffrey Cooper, who was working independently at the Sidney Farber Cancer Institute in Boston, discovered that specific genes, when tranferred to normal mouse cells, cause cancer. Over the next two years, scientists identified the actual genes responsible for human cancers of the bladder, colon, lung, and breast, as well as for a form of leukemia.

Using gene-splicing techniques, Weinberg's group at M.I.T. and a group led by Mariano Barbacid at the National Cancer Institute (NCI) dissected the DNA sequence of the normal human bladder gene and its carcinogenic counterpart. The teams at M.I.T. and NCI simultaneously reported the one mutation that set these genes apart last November in *Nature* magazine.

The mutation—a replacement of one specific nucleotide with another—instructs the gene in turn to produce one specific amino acid instead of another. Chains of amino acids link together to form proteins, the basic molecules that help cells function. The single change in this amino acid produces a protein that breeds cancer.

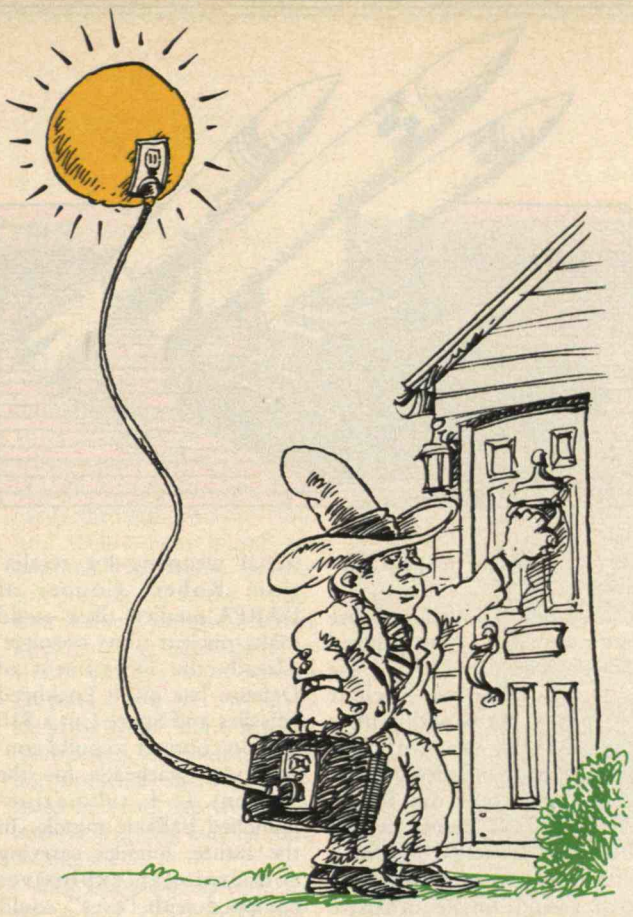
But the researchers have yet to learn how. "Since we have no idea what the function of this particular protein is, we can't explain why this change so profoundly alters the behavior of the cell," Weinberg says.

Because of that uncertainty, Weinberg says the discovery has "zero" use in treatment so far. But it could lead to earlier detection of cancer through tests designed to measure levels of the abnormally altered protein.

The sheer simplicity of the mutation raises a puzzle. "If we had found that there were 10 changes in the DNA sequence needed to activate the cancer-causing gene, that would fit in with the length of time—20 or 30 years—that it takes to develop cancer," says Barbacid. "But this is such a simple change." Weinberg believes it is one of the most important steps in the genesis of cancer. "But right now," he says "we don't know what the other steps are."

Both Weinberg and Barbacid believe the actual mutation is provoked by some environmental effect on the body, such as smoking, diet, chemical pollution or stress. Neither thinks the change is an inherited flaw.

"We think genetic mutation is so harmful to organisms that their tissues wouldn't tolerate its existence" long enough for it to be carried from one generation to the next, Weinberg says. "But we really can't say for sure."—*A.B.* □



Marketing Solar: Down to the Real Nitty-Gritty

Oil distributors selling solar? A former top advertising executive selling something without advertising? Both propositions make sense in the topsy-turvy world of solar-energy retail sales.

Installing solar water heating is a technical second cousin to installing oil heat, so oil dealers are handy at both. As for an ad-man selling without ads, Jackson Gouraud of Servamatic Solar Systems, the former marketing manager at Liggett & Myers Tobacco Co., says that it's the only way to go with solar—door to door, that is.

"I tried [advertising solar] and it didn't work," Gouraud told the *New York Times*. "A consumer has to be hand-carried through the benefits of solar power. There's no way other than spending two hours explaining it."

Gouraud doesn't use display advertising but rather sweepstakes to lure consumers into filling out questionnaires. These are screened for good sales prospects, who are called and visited by sales representatives. Gouraud puts solar water heaters in the great tradition of formerly obscure domestic items—such as vacuum cleaners—that were introduced to a dubious public by door-to-door salespeople.

Nonetheless, says Bernard Smith of the New England Fuel Institute, "they're going to have to push, push, push to sell solar water heaters. That's a $4,000 item, and consumers don't go looking for such a high-cost capital outlay in these economic times."

Smith says that while increasing numbers of the fuel institute's oil dealers are installing solar equipment, both consumer and commercial interest in solar has declined recently. According to him, surveys indicate that in early 1981 about 26 percent of homeowners having energy audits wanted to add some solar. Now that figure is 8 percent. Smith attributes this to the recent stablilization of oil prices and the depressed economy.

Also, businesses are less interested in solar because of a recent decrease in renewable-energy tax credits. The Reagan administration's latest tax legislation altered the way investors figure their combined investment- and renewable-energy credits, effectively reducing all energy credits by 20 percent. The White House wants to eliminate these credits altogether, but that move is expected to fail. Meanwhile, five members of the House Ways and Means Committee have introduced a bill that would double the solar and wind tax credit from 15 to 30 percent and extend all renewable energy credits at least five years past their current expiration dates.

But no matter what happens to the tax credits, Smith says that the current "retrenchment" in solar installations is temporary and has had some salutory effects. Borderline manufacturers and installers have gone out of business, he says, improving the overall quality of the industry's products and services and giving the more competent survivors a greater share of the market. This should allow them to sell more units and so reduce prices, says Smith.

He envisions a resurgence in solar as the economy revives. "When housing starts get going again, I can't believe new units won't be built with at least some solar."

If and when that happens the institute will probably play a leading role. Its Technical Training Center in Watertown, Mass., provides classes in solar energy that have attracted hundreds of American and foreign students annually. About 200 of the institute's 1,300-plus members are now offering solar-energy services.

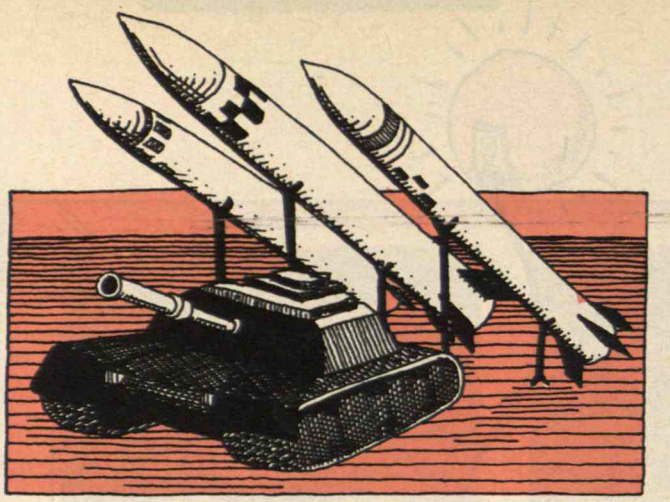
This interest in solar by institute members is partly the result of fuel-oil conservation among their customers. The average home in the institute's area used 1,650 gallons of heating oil in 1978; that was down to 1,050 in 1981 and about 950 in 1982.

It may seem ironic that fuel-oil dealers are embracing solar so whole-heartedly. "Hey," says Smith, "if you can't beat 'em, join 'em. Remember, before they were oil dealers, a lot of them were coal dealers."—*Will Soper* □

Alternatives to Nuclear Weapons

As the momentum of the nuclear-freeze movement grows, military strategists are seriously beginning to consider nonnuclear alternatives for U.S. defense. One of them is Allan D. Simpson, chairman of Global Analytics, Inc., and former director of air warfare for the secretary of defense. He insists that sooner or later, "For political reasons, nuclear weapons will be pushed off the six populated continents." And Robert S. Cooper, director of the Defense Advanced Re-

ILLUSTRATION: JON MCINTOSH



search Projects Agency (DARPA), actually predicts that nuclear weapons may be headed for technological oblivion.

A concept emerging in conservative circles, dubbed "strategic homeland defense" or "assured survival," proposes one way to achieve nuclear disarmament. Diplomatic agreements to reduce nuclear weapons would be coupled with sophisticated conventional weapons and advanced defenses to protect the United States against Soviet missiles, should they be launched.

This concept springs from the "defense-emphasis" school of the mid 1960s, which centered around Donald Brennan and others at the Hudson Institute and Freeman Dyson of the Institute for Advanced Study. Rep. Ken Kramer, a Colorado Republican not noted for dovish sentiments, is currently a leading proponent of this approach. During a recent debate on the House floor, he said that despite his mistrust of the Soviets, a nuclear freeze or even major cuts in the U.S. nuclear arsenal might make sense. He proposes that "our nation deploy a strategic defensive system that would protect against Soviet violation of an arms agreement."

Proponents of this school talk about "ballistic missile defense" (BMD) systems, presumably to distinguish them from the now-discredited anti-ballistic missile (ABM) systems. Traditional arms-control experts fear that there isn't much difference—that the whole scheme is merely a "perilous ruse," as Christopher Paine of the Federation of American Scientists calls it. Yet the assured-survival strategists propose what they consider a plausible scenario for nuclear disarmament.

Step one is a nuclear freeze with a twist. The United States would maintain the same number of nuclear warheads, but would remove the MIRVs, or multiple bombs, from missiles, so each could carry only one bomb. The removed bombs would be distributed among airplanes or other systems that cannot make offensive strikes quickly. At the same time, the United States would protect existing Minuteman silos with a quick-fix BMD, such as Sprint and Spartan missiles. The Vought antisatellite weapon—a kind of Sidewinder rocket that can be fired from an F-15 fighter plane to hit a target in space—would also be used to destroy incoming missiles.

Proponents say this reduces the Soviets' motivation to launch a first strike by increasing the number of targets they would need to hit, while making it harder for them to hit these targets. And moving some U.S. warheads to systems that could not launch a rapid offensive strike would reassure the Soviets. Proponents expect that reduced fears of a first strike would make arms-control talks more fruitful.

In the second stage, a BMD system to block most offensive missiles would be coupled with precise conventional weapons for retaliation. Robert Cooper at DARPA predicts these could make nuclear arms obsolete. Already the Department of Defense has given Lockheed Missiles and Space Co. a $10 million contract to build conventional warheads for the Trident C-4 submarine-launched ballistic missile. In the future, missiles carrying conventional explosives equipped with "eyes" could recognize targets such as transformer yards, fuel depots, and missile silos. Thousands of such missiles or laser beams could cripple the Soviet military machine without inflicting significant civilian casualties. Retaliation would become credible without nuclear weapons.

Assured-survival strategists argue that arms-reductions treaties would be a necessary adjunct to the BMD systems. "With today's high levels of offensive weapons," explains one congressional aide, "it would be impossible for a BMD system to keep all the missiles from leaking through. We won't be able to protect our homeland unless we get the arms-control agreements too."

In the final stage, the United States and its allies would rely on pure defense, renouncing retaliation of any sort. The BMD system would provide security even if the Soviets kept some of their nuclear warheads (a likely prospect, considering other threats such as China).

The possible components of such a BMD system include satellites equipped with heat-seeking missiles to home in on ICBMs; the Swarmjet concept of throwing a buckshot-style cloud of cheap projectiles at incoming missiles; and "directed-energy" weapons such as space-based lasers. It is critical that these defenses be cheaper to build than the offensive weapons they are designed to neutralize. Otherwise, the Soviets could easily escalate their offense.

"This is too complicated for anyone but an American politician to understand," says Wallace Henderson, a vice-president of the BMD Corp., a major defense-oriented think tank. And many are convinced for other reasons that the missile-defense scheme bodes no good. Christopher Paine of the Federation of American Scientists says, "These so-called defense concepts are only likely to continue the arms race. The Soviets will develop countermeasures, the arms race will continue unabated, and stability will be threatened. There is no technical fix for mutually vulnerable nuclear forces."

But despite objections from both liberals and conservatives, a number of members of Congress are beginning to push for this new alliance of BMD, conventional weapons to retaliate, and negotiations for massive reductions in nuclear arms. Kramer sees a transition from "a strategy of nuclear retaliation to one that lets us defend our homeland." How this concept fares as it emerges from the conservative closet will be a major question in the new Congress.—*Carolyn Meinel* □

ILLUSTRATION: SUSAN FALLOWS

Chemistry Goes Underground for Oil

Imagine a huge lump of sandy sponge saturated with oil and buried several thousand feet in the ground. An ordinary oil well sunk into the sponge can extract some 20 percent of the viscous, black stuff. Another 10 to 20 percent can be recovered after it is softened by steam or hot water pumped down the wellhead. But the flow ceases when no more than 40 percent—often much less—of the oil in its spongelike formation has been brought to the surface.

Recovering the remaining 60 percent or more—a total of perhaps 300 million barrels of crude in the United States alone—is the motivation for a fast-developing new technology of enhanced oil recovery (EOR).

Almost all EOR systems begin with drilling a second well, called an injection well, into the formation from which oil is to be drawn. With that task completed, two basic strategies—simple to describe but complex to carry out—are available:

☐ Heat the formation to reduce the viscosity of the oil and hence increase the flow. This can be done not only by injecting steam or hot water, but also by igniting some of the residual oil and fanning the flames with oxygen through the injection well.

☐ Inject chemicals to wash the oil out of its rocky medium, much as someone would remove oil from dirty clothes.

But a host of strategies and problems are concealed in these two brief descriptions, and EOR now accounts for but 400,000 barrels a day of U.S. crude production—less than 5 percent.

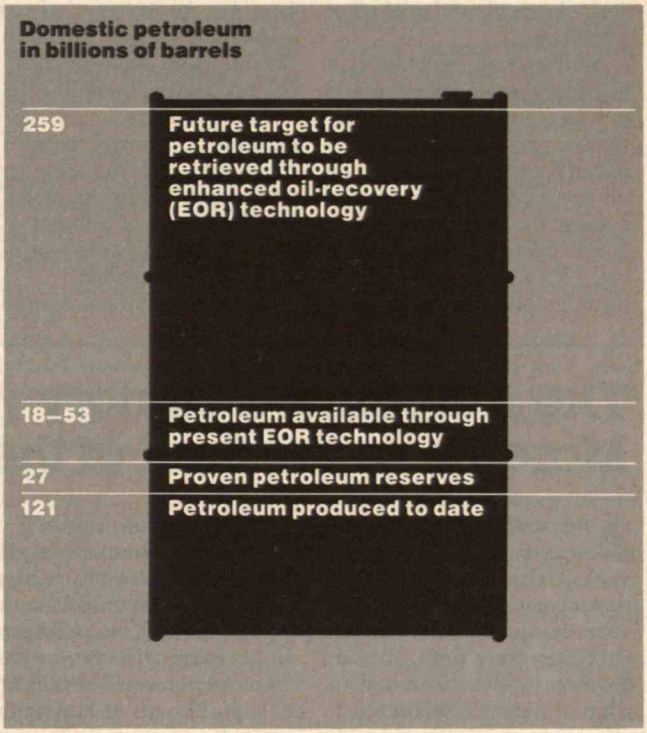
Steam flooding is useful only in shallow, sandy reservoirs at least ten feet thick, where steam can be delivered at high temperature and flow easily through the formation, and where heat losses are minimal. Heating by igniting some of the oil in the formation is likely to have broader application, according to Fred W. Burtch of the Department of Energy's Bartlesville (Okla.) Energy Technology Center. But there are problems—sand may corrode or clog the wellhead, and the burning may be hard to control.

The simplest solvent for use in EOR is carbon dioxide, which blends uniformly with crude oil at high pressure and is especially effective because it frees heavy as well as light hydrocarbons. Other useful solvents include alcohol, liquified petroleum gas, and light hydrocarbons. Alkaline chemicals, such as by-products from wood pulping processes, can also be used to emulsify the oil and bring it to the production well.

But solvents cannot act on oil they cannot reach, and much of the oil at which EOR aims is locked up in pockets of dense material within the reservoirs. Heat and solvents pumped into the injection well avoid these impermeable formations, and the oil in them remains unrecovered. One solution is to add polymers to the injected materials: the polymers gradually clog up the paths through the permeable parts of the oil pool, and eventually the solvents are forced through the less permeable rocks.

Microorganisms may work better than polymers, thinks Professor Michael J. McInerney of the University of Oklahoma. His idea for microbial plugging, he told a three-day symposium on EOR at the American Chemical Society's meeting in Kansas City last fall, is to select microorganisms that flourish in the environment of an oil reservoir, inject them and appropriate nutrients into the formations, and let nature take its course. As the microorganisms multiply, they will clog the permeable materials—where they are most numerous. Other speakers suggested using genetic engineering to breed microorganisms suited to the chemical environments of particular oil reservoirs. But to traditionalists, such proposals are close to heresy. Some microorganisms consume oil in large quantities, and many petroleum engineers want no part of them.

Conducting subtle chemical processes 2,500 feet and more beneath the earth is a complex and costly business, and lots of EOR technology is still in the early stages of conception and development. The EOR method of choice will apparently be different for every reservoir, depending on the reservoir's physical and chemical characteristics, and interdisciplinary teams are needed to weigh the phys-



Primary production methods draw only 20 to 30 percent of the crude oil from a typical reservoir, leaving a large target for enhanced-oil recovery (EOR) systems. Conventional EOR now in regular use in the U.S. is adequate to bring up another small increment. However, a very large incentive remains for perfecting chemical methods for oil recovery involving polymers and perhaps living organisms.

DIAGRAM: OMNIGRAPHICS

ical, chemical, and geological problems.

Simple EOR techniques—including steam injection and in situ combustion—are now in use and can recover between 5 and 35 percent of the oil in reservoirs. The use of carbon dioxide as a solvent could become "significant" by 1987, according to Burtch's EOR timetable, leading to recovery of an additional 5 to 15 percent of the oil. More complex chemical processes, including the use of polymers or microorganisms to control permeability, are still "at least ten years away" from significant use. Recovery of another 10 to 15 percent of reservoir oil may then be possible.

But uncertainties abound, and Burtch estimates that EOR may eventually contribute anywhere from 18 to 52 billion barrels to U.S. oil production. Burtch notes that in any case, this remains "a very attractive target" for a nation whose petroleum reserves are on the decline.

Colin A. Houston, an independent analyst from Mamaroneck, N.Y., predicted "a rapid increase in EOR capability." According to Houston, the market for EOR chemicals was $350 million in 1981, up from only $75 million in 1978. He predicted sales of $800 million by 1986 and $4.7 billion (in 1980 dollars) by 1991, when EOR will be used for up to 30 percent of U.S. crude oil production.—*J.M.* □

The Automated Factory: More Than the Sum of the Parts

American cars cost an average of $1,500 dollars more than comparable Japanese cars, by one common estimate. To become more efficient and thereby lower prices, U.S. automakers plan to put $15 billion worth of robots to work. The only trouble is that labor on the assembly line accounts for a mere 5 percent of a car's cost, according to Bela Gold, professor of industrial economics at Case Western Reserve University. If the robots go on the final assembly line, as Gold thinks most of them will, they could eliminate workers yet not make U.S. cars more competitive.

The conclusion Gold draws isn't that robots are useless. Rather, they are only one part of a properly automated factory. Replacing the parts without rebuilding the whole is like inserting a few gigantic links into a decaying chain. That was the consensus of participants two conferences late last fall: Autofact 4, held by the Computer and Automated Systems Association of the Society of Manufacturing Engineers in Philadelphia; and the Factory of the Future conference, held by the Technology Transfer Society and the American Society for Quality Control in Boston.

Consider one example. While labor accounts for less than 20 percent of costs in the typical factory, according to Gold, materials account for 50 or 60 percent. Yet they are ill kept. "Loads of loafing inventory are a financial iceburg" that hide a large economic loss, said Jamshed D. Elavia, a manufacturing engineer at the Reed Rock Bit Co. in Houston.

Parts awaiting assembly typically are stacked on the floor, damaged, and even lost, said Darrell B. Searls of the Jervis B. Webb Co. in Farmington Hills, Mich. Production supervisors may hoard parts needed elsewhere. Sometimes orders can't be filled on time simply because nobody can find the products to send out.

In a general manufacturing operation, parts are only actually being worked on by production machinery 5 percent of the time, said Inyoun Ham, professor of industrial management at Pennsylvania State University. The rest of the time the parts are waiting in storage or traveling around. By concentrating only on designing the machinery itself, said Ham, "we are optimizing the 5 percent." The other 95 percent of manufacturing is largely ignored.

Proper automation can help organize the entire factory. An engineer designs a product on a video screen; the computer helps with the drafting and calculations. The design may be sent electronically to computerized milling machines, which cut components for the product accordingly. Computers fed with the electronically stored design may direct welding, die casting, painting, assembly, and inspection. Engineering drawings—those labyrinths on paper that have demoralized many a production supervisor—become unnecessary.

But that isn't all. In an efficient factory, the electronically stored design is used to create a bill of materials, to purchase supplies, and to keep track of parts. When a box is unloaded onto the receiving dock, a worker tells the computer that the materials have arrived, perhaps by punching in a code or passing a magnetic wand over them. The computer checks the order and may print out a ticket directing it to storage, inspection, or manufacturing.

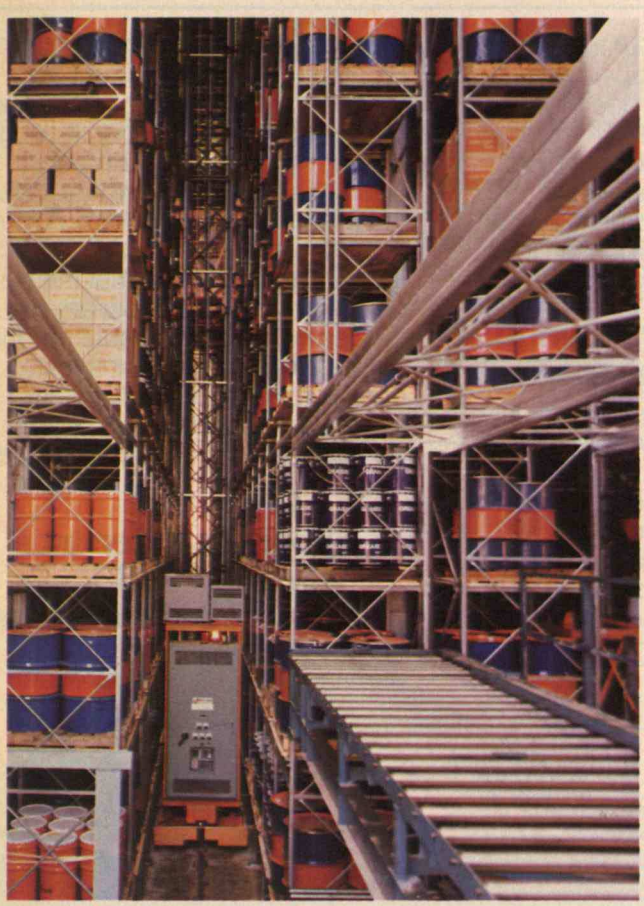
Although the moving might be done by workers, transit systems in some factories are way ahead of Disney World. Some conveyors move parts on pallets, while others walk them along with jerky movements. Guided vehicles can follow wires in the floor, phosphorous paint, or even odors on carpets. Automatic cranes similar to industrial elevators lift parts into what could be called high-rise bureaus. Until computers are told that samples of a shipment have passed inspection, they quarantine the parts.

Systematic automation requires integrating previously disparate departments. "Engineering can no longer make a design and toss it over the wall to manufacturing, which then looks at it and tosses it over the wall to production planning and control," said James L. Ridings, manager of the McQuay-Perfix factory in Staunton, Va.

However, such integration can threaten management. For example, many manufacturing engineers have little or no formal education—they have worked their way up from being technicians, according to Ridings. Such engineers make decisions "by the seat of their pants," one

Automatic material-handling machinery. Parts awaiting assembly in U.S. factories are typically stacked on the floor and even damaged or lost.

Solving such mundane problems through automation can help more than installing robots. (Photo courtesy of Jervis B. Webb Co.)



participant at the conference said, and are reluctant to introduce computers to control industrial machinery and chart the progress of parts through manufacturing.

Speakers concurred that what's retarding automation is not primarily labor unions or technology but management's "educational obsolescence," as Elavia put it. And the higher up the ladder, he said, the worse the obsolescence.

"Many industries today have the technology to automate," agreed IBM vice-president Erich Bloch. "But they don't necessarily have the management conviction to do what is necessary. That is what's holding us back."—*J.S.* □

Workers and Automation

"Japanese workers have made available all their talent and initiative in a way we have not," said Lynn Williams, international secretary of the United Steelworkers of America. U.S. workers "have been hired from the neck down, and they don't respond positively to that. They have no chance to be part of the process of determining their future."

Jamshed D. Elavia, a manufacturing engineer from the Reed Rock Bit Co. in Houston, put it another way. "When American workers understand" what is going to happen in automation, he said, "they are the most likely to respond. When threatened, they can be the most stubborn."

Workers' chief cause of concern about computerized automation is obvious: layoffs. In 1950, 575,000 members of the Steelworkers were employed in industry. When Williams wrote his speech for the Society of Manufacturing Engineers' recent Autofact 4 conference, there were 250,000. And when Williams delivered his speech, only 175,000 remained.

This unemployment is largely caused by technology and not merely the recession, said Williams. Few laid-off members of his union will ever return to their jobs. Williams likened the current decline in the number of manufacturing workers to that of agricultural workers in the past—from 30 percent of the workforce in 1910 to 3 percent in 1980. Even in Japan, the Japanese Productivity Center (a government-supported think tank) is concerned that computers may cause layoffs and threaten the widely publicized lifetime employment systems in many industries.

Technological unemployment is not merely a brief layoff with benefits; it can be calamitous. "A 40-year-old member, with skills acquired over 20 years of work on the open hearth, who loses a job when an oxygen furnace goes on line, has unmarketable skills," said Williams. "And the worker probably has a child in school and a mortgage."

But sometimes automation creates as well as eliminates jobs, and in that case existing workers should be retrained for the new positions, said Williams. James L. Ridings, manager of the McQuay-Perfex factory in Staunton, Va., concurred. He doesn't think layoffs will be as drastic as Williams fears. Although future factories will have fewer workers actually making and assembling parts, they will have a "tremendous need" for workers to do maintenance and overhaul production machinery. Retraining present workers for these jobs is not only good management practice but constitutes "an almost moral responsibility."

When workers are unable to remain employed in the same industry, Williams said they should be trained to qualify for jobs elsewhere. In contracts with the United Auto Workers, General Motors and Ford agreed to invest $120 million and $25 million respectively to retrain workers for new jobs in the auto industry—and outside it.

Unfortunately, retraining efforts are far too meager in this country, Williams said. Last year only 6 percent of U.S. employers provided any job-related (including on-the-job) training for workers aged 25 to 49, according to the U.S. Commerce Department.

Even if automation does enable fewer people to make the goods society requires, according to Williams, the United States must not tolerate an unemployed workforce. Rather than employing a few people full-time and many not at all, industry should establish a shorter work week for everyone. "For all those coffee breaks robots don't take, all the overtime pay they don't require, and all the triple shifts they work without complaint, let us insist," he said, that "our whole society can enjoy the benefits."—*J.S.* □

Exxon introduces offshore oil

Joe Burkhardt helped design a production facility that works on the floor of the sea.

Some of the world's untapped petroleum may be trapped in rocks under water too deep for conventional platforms. That's why Joe Burkhardt and teams of Exxon scientists and engineers have pioneered the development of new technology to take production into deeper and deeper waters.

Breaking new ground beneath the sea

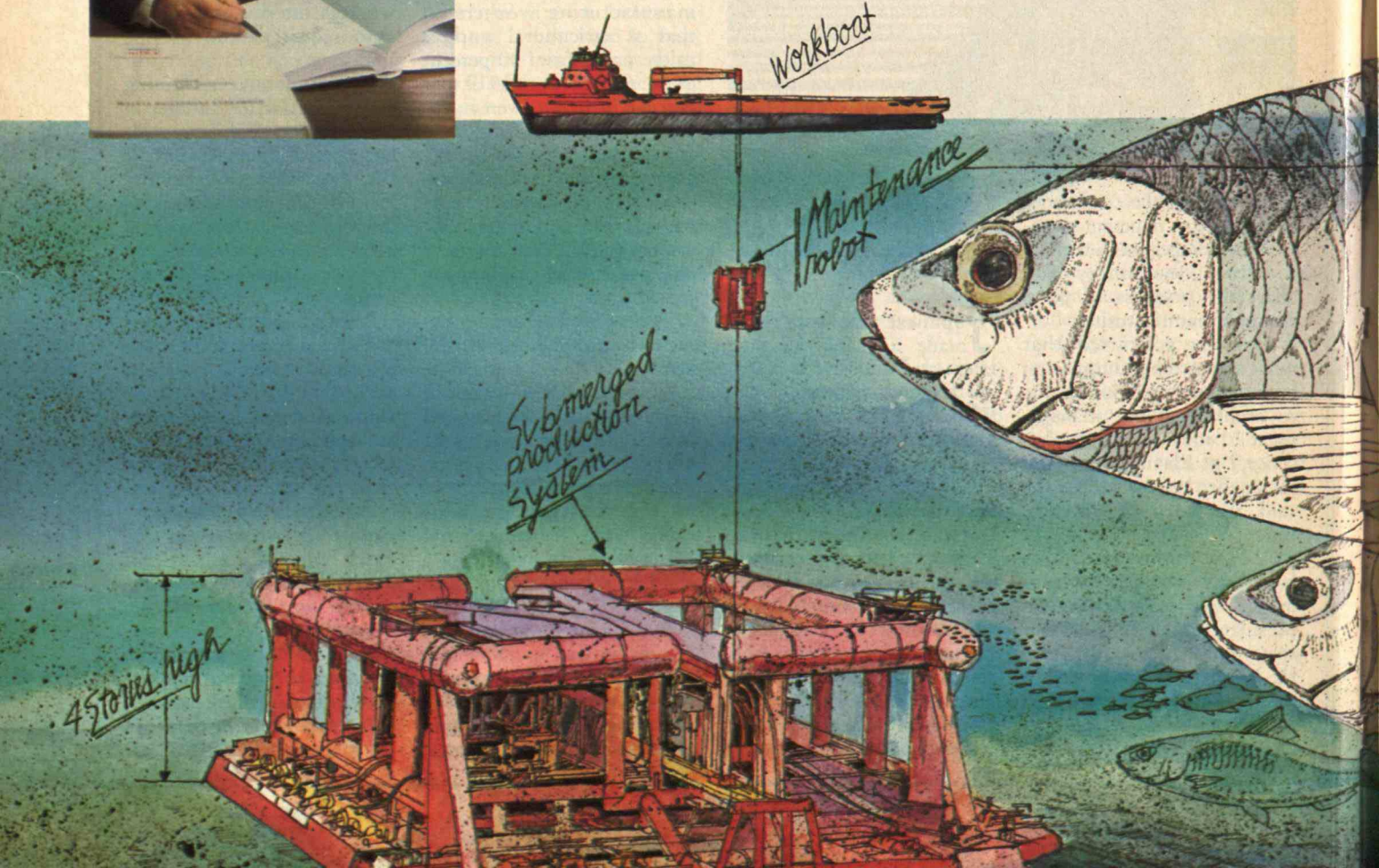
In 1968, Exxon leased tracts off the coast of Southern California, including some under 1800 feet of water. This made it necessary to study ways of producing oil in waters too deep to build platforms. These studies began in a flooded pit near Ventura, California, and culminated in the Gulf of Mexico with the 1974-79 pilot test of Exxon's Submerged Production System—a massive manifold set on the floor of the Gulf.

This prototype SPS controlled three producing wells drilled through openings in its base and delivered the oil to a nearby platform. Although the test was conducted in only 170 feet of water, it proved that the system could produce oil almost anywhere in the sea where a well could be drilled.

Now, three years later, the first commercial application of SPS technology is on the floor of the North Sea, installed by Exxon and another company.

Subsea maintenance by robot

SPS's have the potential to operate in water depths inaccessible to human divers. So Burkhardt and his



a new step in technology.

colleagues developed sophisticated robotics to perform routine maintenance.

The robot Remote Maintenance System (RMS) lowers itself along a buoyed cable from a surface vessel to the SPS. It then travels along a track which gives it access to critical valves and control components. The RMS can replace faulty parts, perform pressure tests and carry out various other maintenance functions. The entire robot operation is observed on closed-circuit television and remotely controlled from the surface vessel.

The SPS and the environment

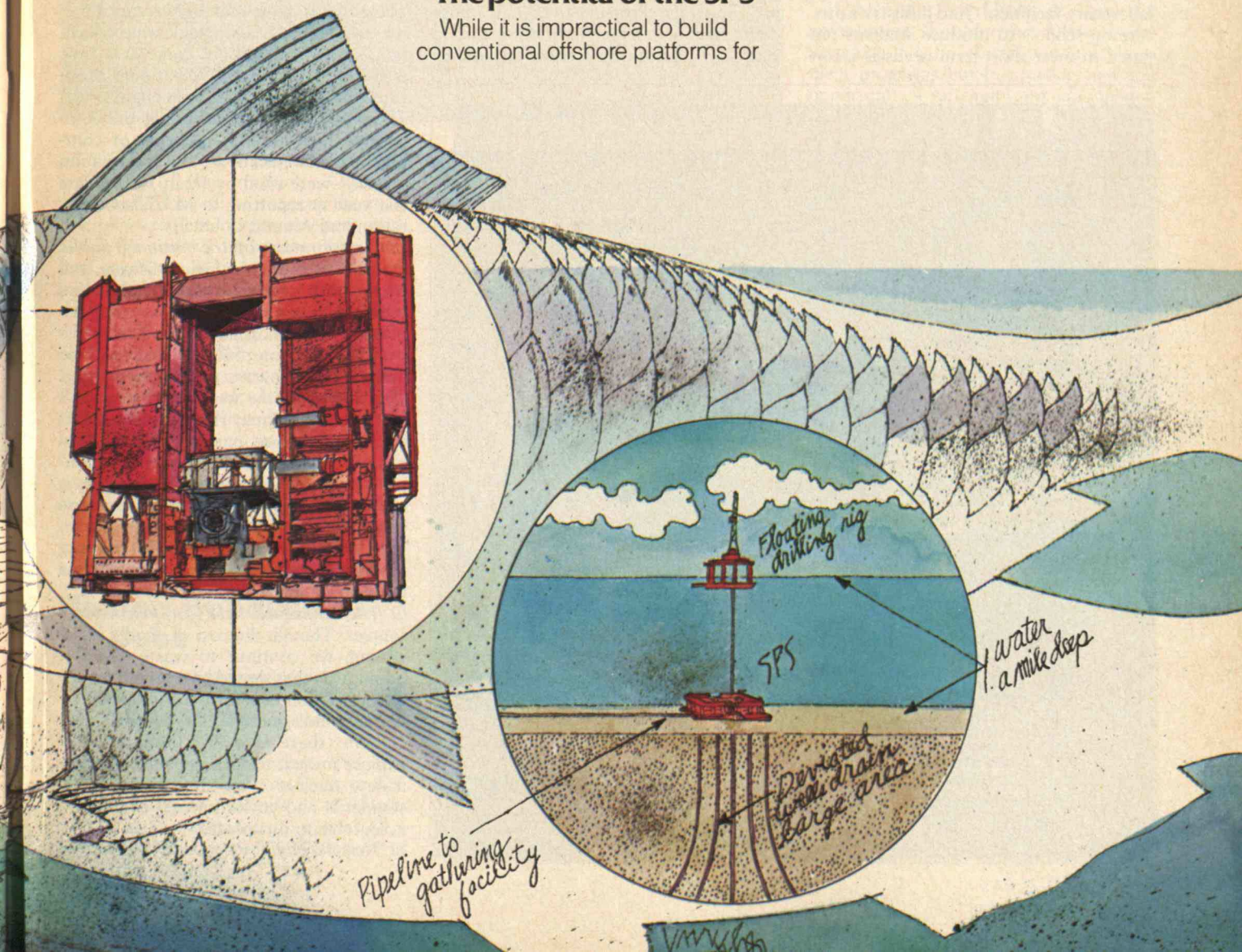
Safeguards incorporated in the SPS reflect Exxon's continuing concern for the environment. A high degree of redundancy is built into many of its subsystems. Fail-safe electrohydraulic control and shut-in systems are used throughout. In the unlikely event that leakage should occur, manifolding on the SPS is covered by inverted "pans" which would collect the leaked oil, trigger an alarm, and stop the leak by closing valves.

The potential of the SPS

While it is impractical to build conventional offshore platforms for water depths much beyond 1,000 feet, SPS technology could be practical to depths of a mile or more. If this full potential is realized, the SPS could be used to open up new areas for oil and gas recovery—areas that cannot be tapped today.

The design and construction of sophisticated deepwater energy systems is just one example of the research and development carried out by Exxon.

EXXON



Engineering: Bloom Amid Pestilence

It is at once the best and the worst of times for U.S. engineering schools, says Professor Gerald L. Wilson, dean of engineering at M.I.T., paraphrasing Dickens' *Tale of Two Cities*—the spring of hope and the winter of despair.

. . . the best of times because engineering schools are now enrolling more students than ever before, and because new technology offers such rich opportunities for engineers to serve the nation.

. . . the worst of times because this great opportunity comes when engineering schools are weak and isolated. There are "major shifts and uncertainty in funding," says Dean Wilson, and "deteriorating laboratory facilities." And industry's pressure on schools to produce students prepared to meet short-term needs is inconsistent with the fact that the new technological opportunities can be fully realized only by "redefining the fundamentals of the engineering disciplines."

To capitalize on their new opportunities and overcome their adversity, says Dean Wilson, U.S. engineering schools need a new relationship with industry—an integration of common concerns that goes far beyond any cooperative efforts of the past.

Eroding Academic Expectations

New data emphasize the pressure on engineering faculties. As 1981 ended, 1,100 faculty positions remained unfilled in U.S. engineering schools, according to the Engineering Manpower Commission's Faculty Shortage Project; over half those desks had been empty for more than a year. In 71 percent of schools responding to a new FSP survey, there has been an increase in teaching loads during the 1980s, in 72 percent greater reliance on graduate teaching assistants and part-time faculty, in 33 percent a decrease in faculty research. Many cited courses eliminated and enrollments curtailed.

And too many of the remaining faculty, originally attracted to teaching and research by the expectation of intellectual freedom and the opportunity to pursue excellence, are disengaged. W. Todd Furniss of the American Council on Education complains that "the traditional expectations of a faculty career can no longer be fulfilled in most institutions."

Trillions for the Infrastructure?

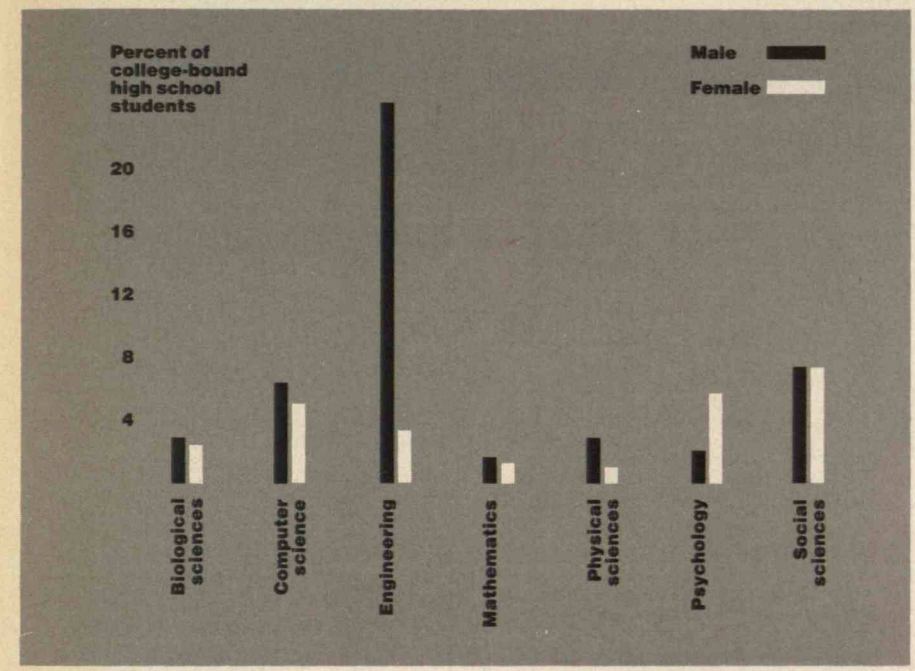
These trends, which can only compromise the excellence of U.S. engineering education, says Dean Wilson, come at a time when there are countless national problems that require advances in engineering. Three of many—not including the competitive high-technology fields of computers, communications, and information science—were cited by Dean Wilson late last year in reporting to M.I.T.'s Corporation and Alumni Council:

☐ *Deterioration of the nation's public works.* Streets and highways, sewers, and water and transit systems all need rebuilding—an immense task in both physical and financial terms. Before the year 2000, some $300 billion will be needed for highways and bridges alone. The cost of all the work on the nation's "infrastructure" may run into the trillions of dollars—an amount that Dean Wilson regards as both incomprehensible and inconceivable. The better route, he says, is new technology—for example, can you imagine a machine that resurfaces the inside of a water main while moving through it, with no excavation and only a momentary interrruption of service?

☐ *The continued need for new energy sources.* Though the cost of energy is declining, we continue to waste valuable liquid fuels that should be reserved for the transportation uses for which they are essentially indispensable. Dr. Wilson's conclusion: there is a "national need to explore nuclear technology anew, seeking a new nuclear cycle that meets safety standards and environmental constraints acceptable to our people."

☐ *New technology and new application*

Over 1,000 budgeted jobs were going begging in U.S. engineering schools in the fall of 1981, according to John Geils, in charge of the Engineering College Faculty Shortage Project of the Engineering Manpower Commission, and the number may have been higher in the fall of 1982. It's just one component of a dilemma confronting U.S. engineering schools, says Dean Gerald L. Wilson of M.I.T.: impaired resources but vast new opportunities.



of it in the design, manufacturing, and marketing of new products. "There is much to be done . . . to integrate the many disciplines required to generate new products" for today's high-technology markets, says Dean Wilson—lessons that seem to have been learned more effectively by the Japanese than by the United States.

In this era when government concern and support are languishing and new technologies are flowering, Dean Wilson says, engineering education must reach out to industry. "We seek a new partnership with industry . . . that transcends the old separation between our missions. We require industry's intellectual as well as their financial resources," he says, and he pledges that what industry gains in this new partnership will be even more valuable than what it gives.—*J.M.* □

No Job Because of No Jobs

Why so much unemployment in the U.S.?

The simplistic answer is that there aren't enough jobs for those who want to work.

And that's the real answer, too, says Katherine G. Abraham, assistant professor of industrial relations in the Sloan School of Management. It's not at all a matter of jobless people being reluctant or inefficient in their search for vacancies, she says.

Professor Abraham has reached her conclusion by comparing unemployment rates and the number of unfilled jobs in the United States and Canada in the 1960s and 1970s. She finds that throughout this period "the number of vacant jobs has typically been much smaller than the number of persons seeking work." Only once, late in the 1960s, did the gap between jobs and job-seekers narrow; that was when the official unemployment rate was between 3.5 and 4 percent. Most of the time since then there have been four or five unemployed people per vacant job, and in the midst of today's recession the ratio of unemployed to vacancies may be as high as ten or more.

If she's right, says Professor Abraham, government should concentrate its investments not in job-training and placement programs but in creating new job opportunities—an important national policy question, she thinks. □

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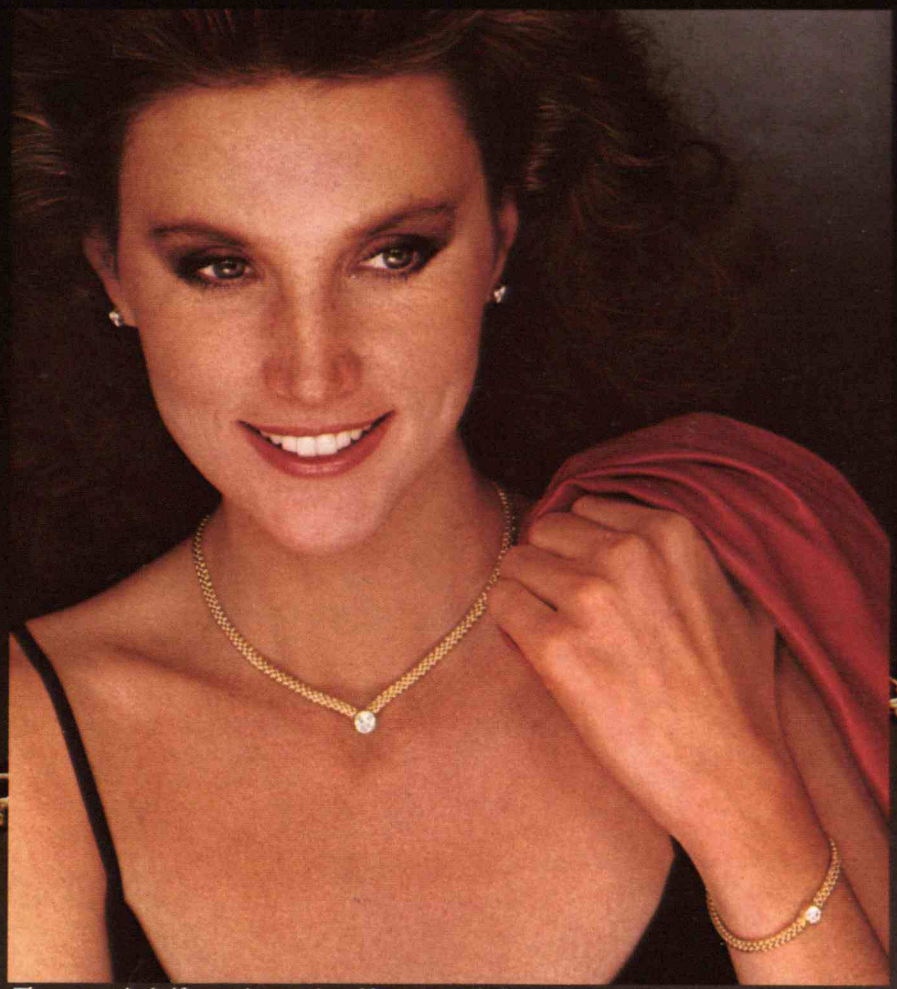

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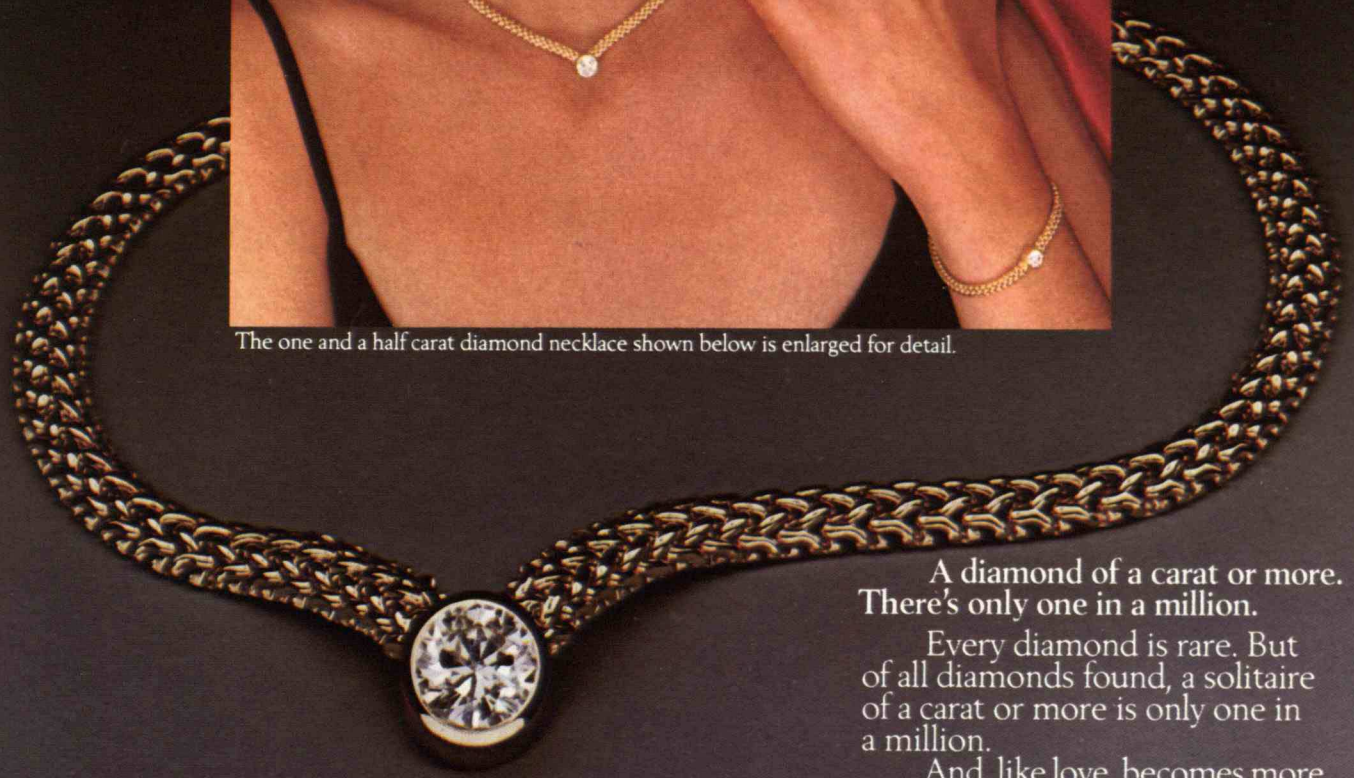

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